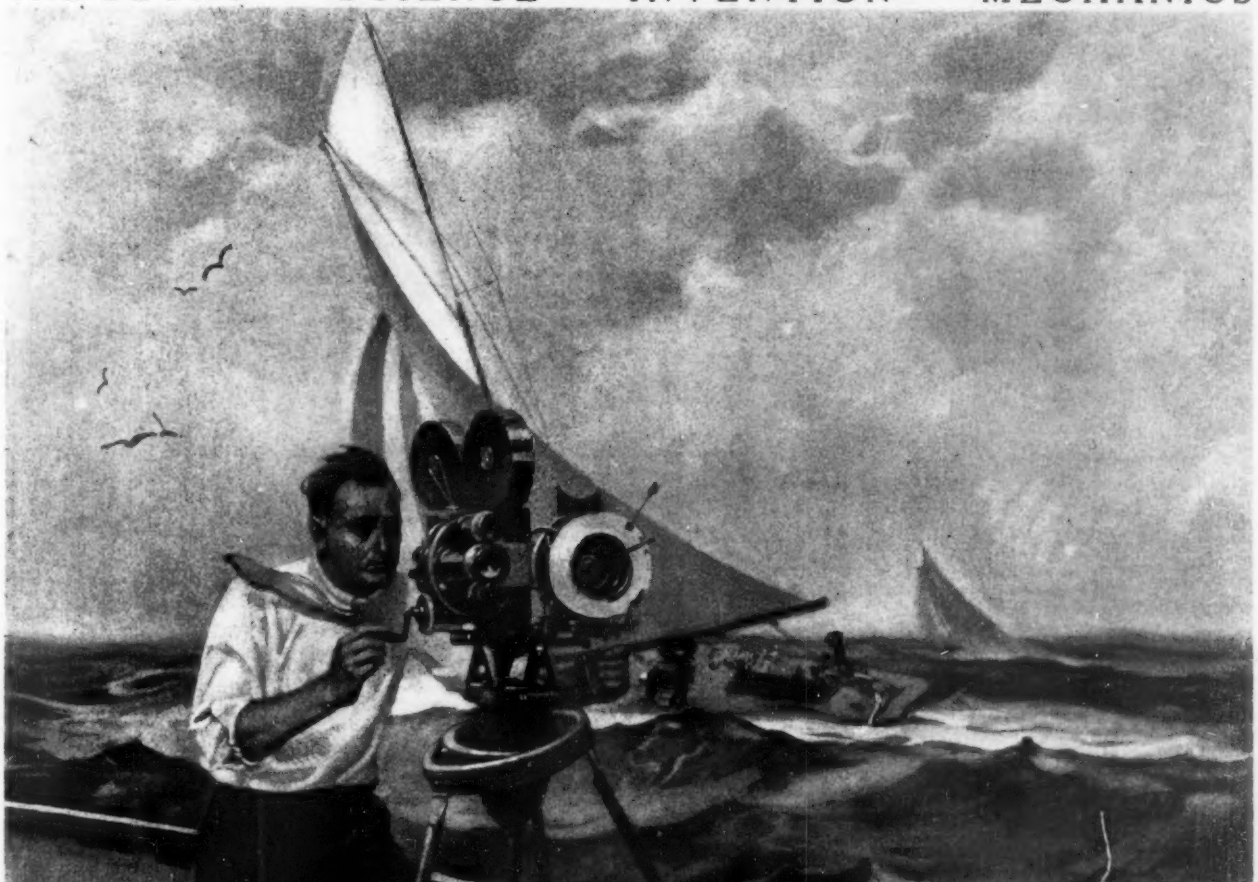
IN THIS ISSUE: OUR FUTURE OIL SUPPLY
LEARNING BY SEEING

SCIENTIFIC AMERICAN

A Weekly Review of Progress in

INDUSTRY · SCIENCE · INVENTION · MECHANICS



KEEPING THE MOTION PICTURE CAMERA ON AN EVEN KEEL.—[See page 107]

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SEVENTY-SIXTH YEAR

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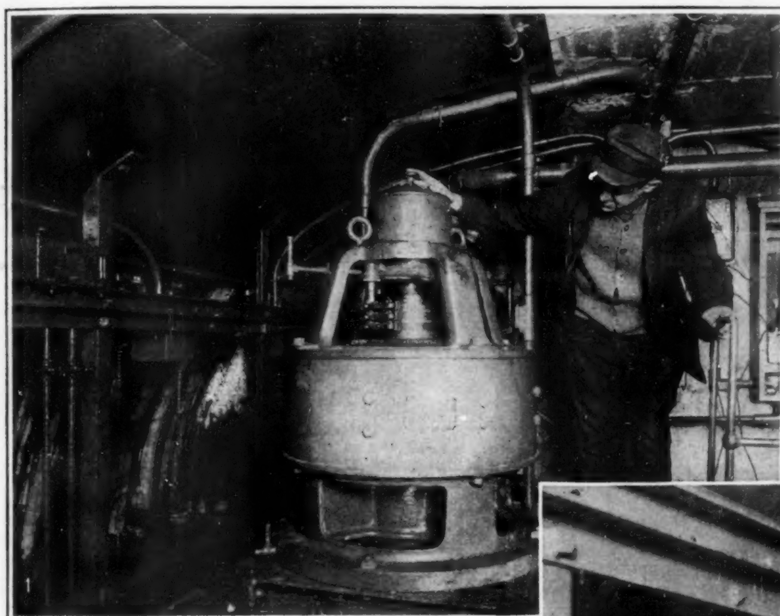

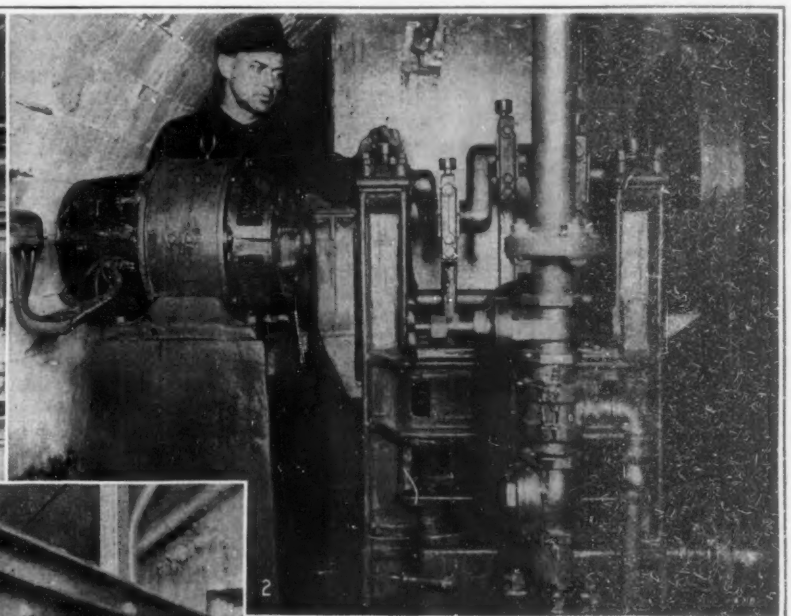

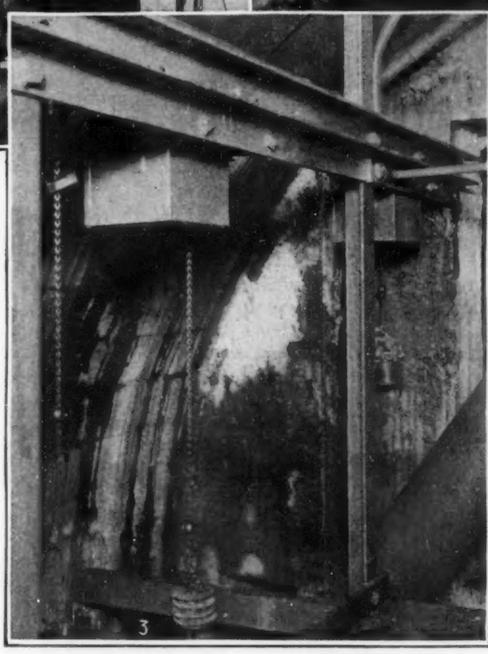

1 The motor that drives the emergency pump. 2. The motor for the pump that handles the ordinary seepage. 3. Sump in which water collects, from which it is automatically pumped

Part of the outfit that keeps the water down in the Queensboro Tunnel under the East River

Keeping the River Tunnel Dry

By M. A. Henry

WHAT would happen if one of the walls of the tubes under the Hudson River in New York should spring a leak?

The thought has probably occurred to every person who has passed through one of these great tunnels in a train. And then we promptly forget about it, for nothing of the sort apparently ever happens. But most of us will be surprised to learn that water from the river overhead is constantly seeping in and that scores of automatic sentinels stand guard day and night not alone to insure that this seepage shall be kept under proper control, but as well to guard against the disastrous possibility of an actual break in the tunnel wall which would admit the water in greater volume.

These sentinels are electric pumping stations located at intervals along the tunnels. They are entirely automatic and need only an occasional inspection to ascertain that everything is in working order.

Each pumping station consists of two main units, a small pump for taking care of the water which ordinarily drains into the tunnel, and a larger pump for emergencies. Both pumps are driven by electric motors and are controlled automatically. The water collects in a sump in which there are two float switches, one for each motor, and when the water rises to a predetermined point the float switch for the smaller motor closes. This energizes an automatic contactor which starts the pump. When the water in the sump is brought down to a proper level, the switch opens and stops the pump. But should the smaller pump be unable to handle the flow, the water continues to rise until the larger pump is automatically started through actuation of its float switch.

The photographs show a typical installation in the Queensboro Tubes, under the East River. The smaller motor is of two horse-power and it drives a reciprocating pump with a capacity of 50 gallons per minute. The emergency pump is driven by a 100-horse-power motor. It has a capacity of 1,000 gallons per minute. There are twenty-five such pumping stations in this tube. A noteworthy feature of this installation is that it occupies a floor space only 12 by 15 feet.

Spontaneous Combustion Temperatures of Liquid Fuels

AN English engineer, named Mr. H. Moore, has recently been making a series of investigations which are of great importance with respect to the functioning of internal combustion motors, since they concern the temperature at which spontaneous ignition occurs in liquid combustibles. The results of these were recently presented by him in London before the Institute of Petroleum Technology.

Mr. Moore defines the temperature of spontaneous ignition as being that at which a substance surrounded by oxygen or air of the same temperature ignites without the aid of a spark or any other local elevation of temperature. To determine this point he has invented an apparatus which has the merits of being simple in structure and rapid and exact in operation. In this apparatus the liquid combustible to be tested is allowed to fall drop by drop into a hole, pierced in a block of heated steel, whose temperature can be controlled and determined with the utmost precision; at the same time there is admitted a current of air or of oxygen which has been previously heated. Mr. Moore has made an extensive study by means of this simple apparatus of varying conditions controlling the ignition points, such as the respective quantities of the combustible and of the oxygen utilized, dilution with carbonic anhydride, and the catalytic action of the metal of the test hole, finding that all these factors have but very slight effect.

The experimenter has formulated tables of the temperature of spontaneous ignition in air and oxygen of a large number of combustible substances, including crude petroleum, various products and residues of distillation, coal tars and distillates, schist oils, alcohol, and purely organic products. By a study of these tables he has been led to the following conclusion:

1. Among the distillation products of petroleum the lightest products possess the highest ignition points.

2. The same rule holds good for coal tar products, but all aromatic products possess ignition points higher than those of the products of the distillation of petroleum at a corresponding point of ebullition. Olefinic products such as the pyrogeneous essences ignite at a lower temperature than the corresponding saturated hydro-carbons.

3. The temperature at which spontaneous ignition takes place in oxygen is generally lower by from 100°C. to 170°C. than the temperature at which ignition occurs in the air.

Mr. Moore has likewise constructed a number of highly interesting curves illustrating the variation of the ignition points according to the proportions of various mixtures of possible substances such as gasoline (petrol) and benzol, and the essence of cannel-coal-creosote and has demonstrated that a small quantity of a component having a low ignition point exerts a very much greater influence than does a large proportion having a higher ignition point.—By *M. Tevis.*

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

How Fast Can a Yacht Sail?

GENERALLY speaking, the speed of yachts is over-rated, and you may safely take from twenty to thirty per cent off when your friend tells you that his craft has done so and so. On the other hand, there are some well authenticated records of high speed made by racing yachts under favorable conditions, which show the best of them to be wonderful examples of the science and craft of shipbuilding. The maximum speed of a yacht, supposing that her model and the cut of her sails are correct, is dependent upon certain adventitious conditions, such as the right kind of wind, the sea, and (above all) the skipper. The ideal conditions for speed are when a yacht is reaching in a smooth sea with the wind over the quarter, that is well abaft the beam, and with everything set that she can carry without an excessive angle of heel.

A well-known authority, Major B. Heckstall-Smith, author of "The Complete Yachtsman," in answer to the question, "How fast can a racing yacht sail?" states that at full speed a racing schooner about 105 feet on the waterline can do about 15.8 knots. This would be in a strong breeze with the wind on the quarter. Assuming that this speed is about right, as he believes, he tells us that with exactly the same breeze, a 90-footer can go 14.2 knots; a 75-footer, 13.4 knots; a 60-footer, 12 knots; a 50-footer, 10.9 knots; a 36-footer, 9 knots; and a 20-foot boat, 7 knots.

Now as to verification of these surprisingly high rates of speed. Beginning with the big fellows, let us take the three-masted American schooner, "Atlantic," which won the Kaiser's Cup in the transatlantic races. The log of the yacht shows that during this race, the famous schooner averaged 14.2 knots for twenty-four hours in mid-Atlantic, and one occasion on Long Island Sound she made an even 16 knots in smooth water and a strong reaching breeze. The Watson, two-masted schooner, "Rainbow," 115 feet long, is quoted as having actually logged 16½ knots. The fastest speed that Heckstall-Smith ever measured with accuracy was when sailing on the 104-foot schooner "Germania," when she made an even 15 knots off the Isle of Wight.

Coming to the 90-footers, the same authority tells us that he was in an historic race, sailed in a gale of wind from Rothesay around Hilsa Craig and back, a distance of 75 miles—a close reach on the way out and broad coming back. The average speed of the winning 90-foot yawl "Sybarita" was 12.3 knots.

A much higher speed, unquestionably the fastest speed on record for a 90-foot yacht, is that given to us by William Butler Duncan. He tells us that in September, 1899, after the Herreshoff yacht, "Defender," had finished acting as trial horse for the "Columbia," he brought her down from New London to City Island, where she was to go out of commission. It was the last time this beautiful craft was under canvas, and as there was a 25- to 30-knot breeze which held true for the whole trip, Mr. Duncan laid a course sufficiently under the lee of Long Island to insure smooth water, and seized this opportunity to determine just what a racing 90-foot boat could do with a strong wind over the quarter. So he put her to the test with full mainsail, with a jib header above it, fore staysail, jib, and small jib topsail. The "Defender" left New London at 6:07 A. M., and reached City Island at 12:24. After making allowances for the tides, he found that the average speed for the whole 86 miles (knots) was 13.8 knots, and by patent log, the actual speed through the water for two hours was shown to be 14.5 knots, which agrees very well with Heckstall-Smith's estimated highest possible speed of 14.2 knots.

The other estimated maximum speeds could doubtless be verified by yachtsmen who have owned racing craft of the various lengths mentioned, although we think that 13.4 is a little high for a 75-footer. As to the smaller classes, the writer once sailed at 21-foot knockabout from Bridgeport to City Island in half a gale of wind. The course was laid under the lee of the New York shore. The wind was over the quarter and under storm jib and with all reefs in the mainsail, the little boat showed an average speed after tidal corrections had been made, of 7.2 knots.

The Engineering Skeptic

ENGINEERING practice in its broadest sense covers the process of reasoning which leads us to seek any result whatever through a particular course of action. It is as much engineering practice when the naked savage shoots his arrow a little up the wind to allow for the inevitable deviation as when the modern bridge-builder calculates the load which his structure must bear and the dimensions which will enable it to bear it. And in this broadest sense of the term we may recognize that engineering practice has passed through several distinct periods.

On general grounds there are two fundamentally distinct viewpoints which may be held by the man who approaches a task. He may attempt in some way to predict the result of attacking his task in this way or that way or the other way, and on the basis of such prediction to select the most advantageous procedure; or he may assume at the start that such prediction is futile, and work out his own salvation through a process of trials repeated until an acceptable procedure is revealed. An offhand opinion of almost any intelligent observer would doubtless be that the second-named method is the one originally employed by the primitive engineer, and that the progress of civilization might fairly be marked by the extent to which the process of performance based on prediction has supplanted the crude method of try-it-and-see.

The fact is, however, that there has been a certain swinging of the pendulum between these two procedures. The Greeks, with their supreme contempt for any disconcerting facts which might operate to bankrupt a pleasing theory, assumed that things would work the way a man with an artistic temperament would like to see them work; and in one way or another, they managed to "get away" with this philosophy. After the decay of Greek thought, the world was for many centuries very largely dominated by the try-it-and-see school of thought—people tacitly admitted that they didn't know much about anything, and that the way to find out whether a plan would work was to try it out. The world was kept from complete adherence to this way of doing things by a child-like confidence in the surviving fragments of Greek knowledge and dogma; but in the main the Middle Ages answered practical questions by trial. That their trial was not always an intelligent one, as when they determined guilt by the ordeal, does not touch our argument.

As the modern scientific viewpoint came into being, however, it was realized that valid general inferences might be drawn from specific instances. This led to the formula, deduced from experience and experiment and applied in advance to tasks to be undertaken. The child-like faith of the Greeks in the ability of the human mind to reason out all things on a basis of beauty of thought was replaced by an equally child-like faith in the universal applicability of the formula.

Today engineers are swinging well in the other direction. It is recognized that while the laws of cause and effect are universal, they apply to human affairs theoretically rather than practically. If we apply the formula too freely we shall presently catch ourselves applying it blindly in circumstances that are not exactly parallel; for circumstances are seldom identical, and we can seldom know to what extent and in what manner they differ. And this heads us straight toward disaster, as the many failures of engineering undertakings which seemed on solid ground demonstrate.

So today we still predict by the aid of formulas, and we use in fact more formulas and more complicated formulas and more precise formulas than ever before; but we bring to the aid of the formula an auxiliary, a far less expensive method of try-it-and-see than is involved in the failure of a complete machine to function, or the collapse of a Quebec bridge. Wherever possible we have tests and tests and then more tests, on a full scale or a miniature scale or any scale that is practical; and it is only when by this means we have made as absolutely certain as is possible that the formulas we have applied to the problem in hand are really applicable to that problem, that we proceed to the decisive step of final performance. So in a very large and fine way, the present has become again the age of engineering by trial and error—trial and error directed toward the intelligent control of intelligent prediction.

Oil Firing in the Atlantic Service

IT is a serious matter to make any radical change in the motive power of the great transatlantic liners, after they have once entered the service. Such ships as the "Olympic," "Leviathan," "Imperator" and "Aquitania" would cost to construct today from fifteen to twenty million dollars, and how expensive it is in these days to do any extended refitting is shown by the estimates of cost, recently made public, of the proposed change of the "Leviathan" from a coal-burning to an oil-burning ship. The fact that the owners of the "Olympic" and the "Aquitania" did not hesitate to withdraw these great ships from service for several months, at a time when they could have been filled to the limit on every trip to Europe, and their willingness to go to the great expense of fitting them with oil-burning equipment, shows how great must be the economic and the other collateral advantages of oil burning in passenger ships of this magnitude.

The "Aquitania" and the "Olympic" can take on 6,000 tons of oil fuel in six hours, as against the four days which were necessary for taking on coal. The latter operation, as everyone knows, is a noisy and altogether dusty and dirty job; the re-fueling of an oil-burning ship on the other hand is a mere matter of hose connections and is altogether silent and cleanly.

One of the most valuable advantages of the change is its effect upon the labor question on shipboard. The number of firemen, which on the largest liners ran into several hundred for coal operation, has been reduced by over seventy per cent, and in the "Aquitania" there will be but four firemen on each watch. There is the added advantage that the total power developed at the boilers is under the direct control of the engineer. In the "Aquitania" there are no less than 168 furnaces; and everyone knows that there is a drop in the steam pressure every watch during the cleaning of the fires. If it be assumed that 28 out of the 168 furnaces are cleaned every watch, it means that about 8,000 horsepower is lost every four hours.

Now, with oil-fired boilers there is no such thing as clogging up of the grate bars by clinkers, and consequently there is no letting down of the steam due to cleaning operations. Once the burners have been started, the temperature of the furnace can be maintained with great regularity. The large reduction in the boiler-room force, coupled with the better-regulated combustion of the fuel, combine to produce great economy as compared with coal firing. Incidentally, it may be mentioned that the reduction in the fire-room force will go a long way to prevent the holding up of the ship on the point of sailing by suddenly announced strikes among the stokers.

Here in America, we have been fore-handed in the adoption of oil firing. The Shipping Board from its very first inception, grasped the great opportunity afforded by our construction of an entirely new fleet of ships and has made a wholesale introduction of the new system. The United States Navy also, is largely oil-firing and probably has a much larger percentage of oil-fired ships on its register than any other navy. This is particularly true of the capital ships and the destroyers, of which we built or commenced a great fleet during the war.

Aeronautics

Descent at 450 Miles per Hour.—Lieut. Weiss of the French Army, was attempting to establish a height record recently but unexpectedly found his supply of oxygen virtually exhausted. The Paris correspondent of the *Morning Post* states that at the moment he was at 8,000 meters and his only chance of safety was to nose dive. For a certain number of seconds he achieved a speed of 450 miles per hour and actually traversed 4,300 yards of descent in thirty seconds. The machine was injured as a result of the strain and certain portions of the wings were torn off, while some supports also were broken before he was able to flatten out the machine for landing.

Aerial Traffic Policemen.—During the recent yacht races off Sandy Hook, N. J., the aerial policemen of New York City were given an opportunity of proving their worth. As it was, numerous aircraft hovered over the course of the racing yachts, and some of the more adventurous pilots essayed aerial stunts in order to attract attention. Soon the aerial policemen of the metropolis came on the scene in their high powered airplanes and immediately complete order and straight and sane flying obtained. While the work of the aerial policemen has been slow through lack of funds and support, it is safe to predict that this organization is steadily forging ahead in its work. The personnel includes some of the leading American fliers, and there now appears to be sufficient equipment and facilities to take care of the present aerial traffic.

Mr. Fokker Speaks.—Before the Royal Dutch Aviation Association at Rotterdam not so long ago, Mr. Fokker, the well-known designer of numerous German planes, expressed the pious hope that it would not be necessary for him to seek financial help abroad again, but that it would be found in his own country, Holland. He emphasized the need for developing machines which could leave the ground after a very short run, and instanced his new commercial machine as an example of what could be done. He expressed the idea that the improved reliability of airplanes would render seaplanes superfluous for overseas work except for trips between islands. He also pointed out the necessity for the extension of the application of wireless telephone and telegraph, and that the improvement of instruments for ascertaining heights, and so on, is necessary in order to make flights possible in fog at night, and under other hampering conditions.

Zeppelins for France.—*Aeronautics* says: France is to take possession of the two Zeppelins which fall to her share under the terms of the Treaty of Versailles. One is the L-72 and the other the LZ. of more recent construction. One will be allotted to the navy and will be stationed at Cuers-Pierrefeu, a naval aviation center in the Var. The other will be transferred to the Under-Secretariat, and will be housed at Maubeuge, in the hangar which the Germans enlarged during hostilities.

Aviation and the Inventor.—Writing of inventions we are inclined to believe that there is no field that offers more opportunity to the inventor than aviation. The science is really still in its infancy. Apart from actual constructional devices, there are so many obvious defects in the airplane that require remedies. Chief among them is the necessity for a braking device to give the machine only a few feet of run upon landing. Tail skids galore have been produced, but none can claim to be really effective. Brakes on the wheels have been tried, usually with the result of smashing the nose of the machine. An alterable chord on the wings has not proved altogether successful, and the alterable pitch of the propeller is not popular. The helicopter may come in time, but it is a long way from perfection yet.

Astronomy

Standard Time Adopted in Uruguay.—A circular from the Meteorological Institute in Montevideo announced that, beginning April 30, 1920, the official time throughout the republic of Uruguay would be that of the 60th meridian west of Greenwich. The time signals sent out from Montevideo will in future conform to this time, instead of to that of 56 deg. 12 min. 45 sec. (the longitude of Montevideo).

Salaries at the Naval Observatory.—The U. S. Naval Observatory, in common with the other scientific establishments of the Government, is suffering from the monumental indifference of Congress with regard to the effects of inadequate salaries on the efficiency of the public service. According to the last annual report of the observatory, the amount of research work carried on during the last fiscal year was much less than usual. "This is so," says the report, "because of the necessity of employing the higher-grade assistants on certain routine work that could have been done by the three junior assistants had not these positions been vacant. It has been found impossible to fill these positions because of the low salaries."

Variation of T Pyxidis.—A bulletin from Harvard College Observatory dated April 9, 1920, records the interesting history of the star T Pyxidis, R.A. 9h. Om. 32s., Dec. —31 deg. 58.7 min. It was discovered by Miss Leavitt on photographs made in 1902, and was at first thought to be a nova. Its magnitude was then 7.4. An examination of 400 photographs of the region in question showed that it was also bright in 1890, while during the intervening years it was of about the 14th magnitude. A period of 12 years was thus indicated, but the maximum expected in 1914 did not occur. Recent photographs show that it has again become bright, after an interval of 18 years, its magnitude now being about 7. From a photograph made April 8, 1920, the star appears to have the early form of nova spectrum.

CONDITIONS FOR THE $5,000 PRIZE EINSTEIN ESSAY CONTEST

1. No essay shall be longer than 3,000 words.

2. All essays must be in English, and written as simply, lucidly and non-technically as possible.

3. Each essay must be typewritten, and identified with a pseudonym. The essay shall bear a title and the author's pseudonym *only*, and must be enclosed in a plain sealed envelope likewise bearing this pseudonym. In the same package with the essay must be sent a second plain sealed envelope, also labelled with the pseudonym, and containing a statement of the name and address of the contestant, the pseudonym used, and the title of the essay. It is necessary to follow these instructions implicitly, in order to guard against confusion in opening the envelopes and assigning the pseudonyms to their proprietors, especially in view of the possibility that two of the contestants may employ the same pseudonym. The envelopes should be sent in a single package to the Einstein Prize Essay Editor, SCIENTIFIC AMERICAN, 233 Broadway, New York.

4. All essays must be in the office of the SCIENTIFIC AMERICAN by November 1st, 1920.

5. The Editor of the SCIENTIFIC AMERICAN will retain the small sealed envelopes containing the competitors' names and addresses, which will not be opened until the competitive essays have been passed upon and the winning essay selected.

6. As soon as the judges have selected the winning essay, they will notify the Editor, who will open the envelope bearing the proper pseudonym and revealing the competitor's true name. The competitor will at once be notified that he has won, and his essay will be published in an early issue of the SCIENTIFIC AMERICAN.

7. There shall be but one prize, of FIVE THOUSAND DOLLARS, to go to the author of the best essay submitted.*

8. The SCIENTIFIC AMERICAN reserves the right to publish in its columns, or in those of the SCIENTIFIC AMERICAN MONTHLY, or in book form, any of the essays which may be deemed worthy of this. Aside from such rights, the essays shall remain the properties of their authors; but no manuscripts can be returned.

9. The number and personnel of the Committee of Judges will be announced in an early issue.

*[The donor desired that in case the Judges were not able to agree upon the winning essay the prize might be divided between the contestants offering the best two essays, but the Post Office Department has objected to such a condition being published, so the matter is held in abeyance until definitely decided. Announcement will be made later in regard to the matter.—THE EDITOR.]

Engineering

Connecting Japan's Islands.—A project for connecting Nippon, the main island of the Japanese group, with the neighboring island of Kyushu by means of a tunnel starting at Shimonoseki was originated by a Japanese shipping magnate, according to the *Economic Review*, but has been taken over by the Government, which is averse to giving out many details. It is understood, however, that borings have been made in the sea bed near Shimonoseki in order to ascertain the geological formation, and that in order to reduce the angle of inclination, the descent of the tunnel will commence about a mile from the coast, and at first run under the narrow channel between the mainland and the little island of Hikoshima, on which an underground station will probably be built. From there it will run under the actual Strait of Shimonoseki as far as the Dairi district a few miles to the west of Moji, where it will join the Kyushu railway. It is estimated that the construction of the tunnel, which will be six miles in length, will cost $12,500,000, and will be completed in 1929.

Europe's Largest Cold-Storage Plant is nearing completion at the Alexandria Dock, Liverpool. The first section of the store opened in August last, has a capacity sufficient for the storage of 11,000 tons of foodstuffs. When completed the total cubic capacity will be over 3,000,000 feet and the accommodation will approximate 30,000 tons of eatables, including meat, fish, poultry, game, eggs, butter, and cheese. The equipment will be the most modern obtainable. In order to avoid exposure of meat in transport from the ship to the shore, the adjacent dock sheds have been fitted with a system of conveyers which enables the meat to be picked up at any point and conveyed under cover direct to the store, thus avoiding any break in the refrigeration.

Germany's Railroad Electrification.—Coal as a power producer will be replaced so far as possible by the use of peat and the electrification of railroads in the vicinity of the large German cities, according to *Commerce Reports*. Great hopes are being placed on the new Theissen 10,000-horse-power vertical gas turbine, two of which have been ordered for use on the German railways. It is hoped that they will be able to replace the coal-burning locomotives. In regard to the electrification of the German railways near large cities it is planned to install large central power stations, which will be equipped with peat-burning furnaces. The peat bogs in the vicinity of Osnabruck will furnish this fuel. Machinery for the working of this peat has been installed, and it is hoped that the first deliveries will take place by September 1st next. Experiments are being made by the German Government with machinery for pressing the peat, so that it may be transported economically.

The Teredo does not actually eat the wood, but cuts into it as a place of abode while deriving its sustenance from the sea water, according to a recent account in *Railway Maintenance Engineer*, dealing with the ravages of the teredo and other insects of wood-boring habits in timber structure immersed in sea water. Impregnation with creosote has given a considerable degree of protection in many cases, but it has to be very thorough to be effective. Examination of creosoted structures that have been attacked has usually revealed incompleteness of the impregnation. Various forms of protection by external coverings have also been tried, including metal sheathings, coverings of burlap or sacking and protective pipes of cast iron, concrete or terra cotta. Practically all except the actual pipes proved of little value because their usefulness was quickly destroyed by breaks in the covering.

Our Future Oil Supply

A Hopeful View of the Possibilities of the Mexican Fields

By A. Hooton Blackiston

In the midst of the prevalent gloom over the petroleum situation, it is refreshing to hear a note of optimism. We are usually told that the American supply is diminishing and will continue to diminish permanently; and that no substitute source of supply is in sight. Mr. Blackiston speaks from long familiarity with the Mexican field, and argues that this is not the case—that the republic south of us may be looked to for ultimate stability and a very large quantity of oil products.

But with his hopeful outlook he couples the suggestion that unless we bestir ourselves, we shall find the world's liquid fuel as completely in other hands as in the past it has been in ours. It is no remote inference, granting the validity of his arguments, that we may yet see the day when Britain will wallow in petroleum as we do now, while we parcel out the precious gasoline by the quart and even the pint, as Britain does today.
—The Editor.

THE age of petroleum is here. From an humble beginning in 1859 it has now reached a point where it is consumed in ever increasing quantities until the problem of its production has become one of the most absorbing of international questions—to that country which controls the output belongs the power of the world.

Therefore, Great Britain, the smallest producer though realizing its importance, is struggling with every nerve set to acquire through purchase or otherwise the control of the known or prospective oil bearing areas of the world in Persia, Burma, China, the Balkans, Peru, Venezuela, Mexico and even in our own country. Meanwhile America, the home of the industry and the world's largest producer and consumer, sits idly by and watches its laurels slowly fade away.

Oil production means control of the sea and of the air and consequently of the land. It is time our Government wakened from its lethargy and encouraged production at home and abroad if we are not to be left behind in the race. Though we have produced over 60 per cent of the world's supply to date, we are now consuming more than we produce and the demand is increasing by leaps and bounds.

Petroleum is the genie that answers the lamp of Aladdin in a far more effective way than did the genie of the fable. It courses over vast stretches of country in its own pipes to do our bidding, it draws our trains, it cultivates our crops, it harvests them and hauls them to market, it drives and lubricates the wheels of industry, it heats our very buildings, it propels our navy and merchant marine, and in the submarine and the airplane it broks no rival. It does its work smoothly, effectively and economically.

And petroleum we must have, for we have built millions of machines that use nothing else and thousands of miles of road good only for them; we have adapted our vessels and locomotives to its use and are every day becoming more dependent upon it. Not a wheel turns but pays tribute to petroleum. Its sudden cessation would rock our present day civilization to its base.

The products refined from it are legion. There are over three hundred separate products made from petroleum. High explosives are distilled from it, medicines, dyes, and even artificial flavorings—and yet we have but begun to understand this modern wonder-worker.

It has cheerfully lifted the burden of labor from the back of mankind and his steadfast friend, the horse, and saved the drudgery of countless millions. In war it is our defense, in peace our aid, and in sickness our solace and our comfort.

However our reserve storage of crude oil has fallen off in the last eighteen months fifty million barrels and is decreasing at the rate of 10,000,000 barrels a month. In the face of these facts it is time we realized its national importance and looked ahead for our future supply.

The world's total output was 514,724,354 barrels in 1918. The United States produces approximately 69 per cent of the oil of the world and when combined with Mexico, about 81 per cent. In 1919, while we produced in round numbers 376,000,000 barrels our consumption was about 418,000,000 barrels; the difference of about 42,000,000 barrels was imported from Mexico, our nearest available foreign supply and the country which contains the premier wells of the world. Therefore, the Mexican fields are of particular interest to us when debating from whence our future supply is to come.

The petroleum industry in Mexico is only sixteen years old. It may be said to have been begun by Americans in 1904 in the Tampico district, though oil seepages were noted by the early Spandiards, and an attempt to drill was made in 1868, with no important discovery.

And yet, in spite of the newness of the industry and the numerous setbacks it has experienced through political conditions, the possible production of the country is estimated at nearly 2,000,000 barrels a day, though less than 9 per cent of this amount is exported at the present time, and but a fraction of Mexico's oil territory has even been prospected. In the brief sixteen years of its development it has climbed to the place of second producer of the world, and its wells are without a peer—indeed so far ahead of the others as hardly to admit of comparison.

It is a long cry from Drake's pioneer well near Titusville, Pennsylvania, in 1859, with its feeble stream of forty barrels a day, to the monarch of the world's wells, the famous Cerro Azul No. 4 of Mexico, which tossed its black column six hundred feet high into the air, and in unbridled freedom hurled over one million barrels of oil toward the skies before it was finally placed under control. It gushed at the rate of nearly three barrels a second, which would be 180 barrels a minute, 10,800 barrels an hour, or nearly 259,200 barrels a day, and at present is filling its eight-inch pipe lines running direct to the tankers at Tampico which are waiting with eager maws its flood of liquid gold. It is now producing at the rate of about 125,000

(Continued on page 112)

1. The standard bearer of our future oil supply—the test well, which today, with the aid of the scientist and the latest mechanical devices, indefatigably searches out the pools of hidden oils and opens new fields. 2. The driller has to be constantly on the job. 3. Incidents like this one in our own oil fields do not help matters.

Snapshots from the oil fields of Texas where oil is king

Left: An ancient installation of a type now almost forgotten. *Right:* The No. 1 board in the Chelsea exchange, New York City

Thirty years' progress in telephone switchboards—to say nothing of feminine apparel

Scrapping Good Machinery for Better Service

By H. A. Mount

OUR great public service corporations spend many millions of dollars every year in replacing machinery and equipment, the mechanical usefulness of which is almost unimpaired by use. It is replaced because it has been antiquated by some new invention or development that gives better service.

To the uninitiated it would seem that the public might be spared a very great expense if this constant replacement of good equipment were stopped, or at least carried on less vigorously. But even a superficial examination of the facts discloses that it pays. Not only from the standpoint of the public is the process an economical one, but it pays dividends to the companies. And of course, that is the real reason for it. It pays so largely that the largest companies maintain great research organizations whose business it is to make antiquated the company's machinery and equipment—to find new ways of doing things.

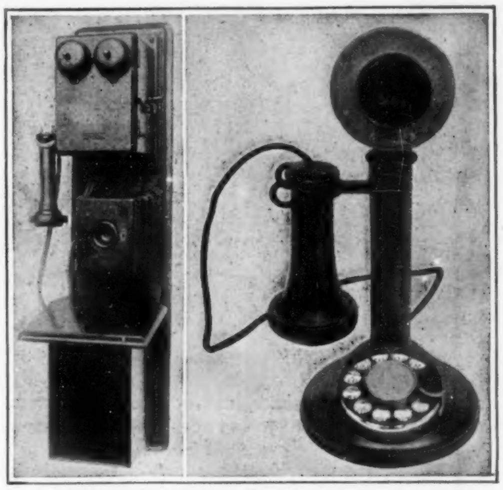
One of the striking examples of these statements is the electric light and power companies all over the country. There is hardly a central station in the United States which has not almost completely changed its equipment within the last ten years because of the rapid strides in electrical engineering. And yet the original equipment, if it had not been junked, would in most instances have been giving just as good service today as it did when installed.

The largest single powerhouse in the world, in point of electrical output, is one of the great stations which supply power for the operation of New York's subway system. Eight years ago this station was equipped with great reciprocating engines of 100,000 horsepower each, that were the finest engines of their kind in existence. It was estimated that they were good for a century of service. And yet today only one of these great engines still stands and it is used only in emergencies. The others have been replaced by a battery of comparatively small steam turbines that take up much less space and have a far greater power output.

The saving in fuel alone justifies the junking of all this costly machinery. The saving in space allowed for great expansion in power capacity without additional buildings. In this case junking good machinery has paid big dividends.

An even more striking example is our telephone system. Constant replacement is going on here on a stupendous scale. The most recent development in telephones is the automatic switchboard which does away with the much-abused but faithful servant "central." Connections are made automatically. The introduction necessitates replacement of almost the entire telephone equipment, but already the process has been begun and eventually it will extend to every city and town in the country. The saving in labor alone justifies the cost, aside from better service to the public. There will be no reduction in the number of employes, however, because of expansion of the system.

A few years ago the great mass of telephone wires in the cities made it necessary to use cables for transmission. At first only a few wires could be placed in a single cable and even then what seemed almost insurmountable difficulties presented themselves. The great cost of the cables and the expense of laying them, especially underground cables, made it necessary to put as many wires as possible in a single cable.



The Blake transmitter of 1886, and the automatic instrument in use today

An intensive engineering study of this problem has been going on and the difficulties have disappeared one by one as more and more of the overhead wires strung on telephone poles were replaced in cables underground. Finally, it became possible to place as many as 2,400

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The measuring box that reveals the pressure of a road on the bed of soil beneath it

How a Road Rests in Its Bed

By S. R. Winters

THE character of the support given a road surface by the underlying soil and the manner of distribution of pressure when highway slabs are subjected to the impact of heavy traffic, is scientific information for the first time disclosed by an ingenious apparatus designed by the U. S. Bureau of Public Roads. The tests are being conducted on a concrete highway leading into Camp Humphreys, Virginia, where army motor trucks with enormous cargoes of freight constantly travel.

The experiments are being conducted by a measuring box which has immediate connections with a pressure device located between the surface of the highway and the underlying soil. The initial tests showed that the effects of a motor truck at rest are never sufficient actually to shatter the road surface, this knowledge being of valuable assistance to highway engineers in proceeding with experiments in revealing the influence of trucks in motion and the effects of the impact.

It has been discovered that even a concrete road, stable and massive as it appears to be, is never for a single instant perfectly at rest on the underlying soil. It continually vibrates, which movements change the pressure exerted between the road surface and the underlying soil—a condition characteristic of any highway when traffic is passing over it. Irrespective of the size of the object, when a weight is placed on any kind of material, the latter is bound to deflect. The degree of its motion is dependent, of course, on the magnitude of the load applied as well as the kind and shape of the material. A road slab when subjected to oppressive motor truck traffic bends considerably, especially when the slab is resting on soft soil. If the bend is excessive, a crack is formed in the road surface.

The problems of highway engineers are constantly shifting front and each successive stage of changes presents fresh difficulties. In 1899 there were only 3,700 passenger and commercial motor vehicles manufactured in the United States. Previously the horse-drawn vehicle, having iron tires, produced an abrasive effect on roads, the surface wearing out under the continual grinding action. With the advent of the comparatively light motor conveyance, the effect of the rubber tire is to scatter huge clouds of dust, the fine stone particles tending to bind the road together—soon leaving but a stretch of disintegrated stone.

The third stage of highway engineering—the introduction of heavy motor trucks—has brought fresh problems. The new type of conveyance rumbles and pounds over the road surface, in many instances shattering the highways because they are unable to withstand the impact of excessively heavy traffic. So it is now a problem of design—the ultimate object of the Camp Humphreys experiments being to give the engineer complete information for designing highways when the surface rests on any type of soil.

Soap from Lignite Tar Oils

EXPERIMENTS, which have been said to have a satisfactory result, have been carried out in the laboratory of the Siemens works in Berlin, with a view to converting lignite tar oils into fatty acids by the action of ozone. Similar experiments carried out on a large scale by a process introduced by the city of Wiesbaden have led to equally satisfactory results.

The Romance of Invention—XV

Frederic E. Ives, Wizard of Color and Light, and Father of the Half-Tone

By C. H. Claudy

AMONG all the inventors whose work lies in some chosen and restricted field, none has elected a field in which the possibilities have turned out to be greater than in the field of photography. Photographic work, when Frederic Ives first took it up, was circumscribed enough. Largely through his inventions, this state of affairs has undergone a radical change, and today there are few arts of wider or more various application than the art of photography. It is a far cry indeed from the mysterious half-tone, with its little patterns of dots that make pictures, to the achievement of color photography and color motion pictures and color stereograms and the binocular microscope and the stereoscopic photomicrograph. Yet all these extensions of the photographer's province are the work of this one man, whose story Mr. Claudy here tells us.—THE EDITOR.

THE probabilities that the reader has ever heard of a "kromoskop" or a "parallax stereogram" are small. But no one who reads but has seen half-tones, either black and white, two-color, three-color or four-color and has thus had his quota of pleasure and profit from the inventions and discoveries of America's most eminent authority on color processes, the distinguished inventor to whose resourcefulness and ability the world owes its premier method of illustration, indeed, the method which revolutionized the printing industry.

Mr. Ives, who confesses to sixty-four years, of which he looks about fifty, has spent those fifty in photography, first as an amateur, next as what those who recall his work there still speak of as the most competent photographic laboratorian Cornell University ever had, and the rest of the time in his own workshops and laboratories, where he has worked out hundreds of inventions, practically all dealing with light, optics, lenses, color processes and optical instruments of precision and photography.

Mr. Ives' story is so diversified that it is difficult to know where to begin. At best, no story the length of this article could more than outline his achievements. He himself, probably justly, regards his invention and perfecting of the half-tone process as his greatest claim to fame; but it is none so sure that a world well used to half-tones may not longer remember him as the first to invent, patent and perfect a "real" system of color photography as applied to the motion picture.

For this is Mr. Ives' latest contribution to the worlds of science, art and commerce; and that he has succeeded is not claimed upon theory, but upon the actual production of actual films in colors, which colors are in the films themselves, and are not added thereto by means of colored screens, a method which produces a color "flicker" or "color fringes."

It would be difficult if not impossible to describe the process in detail in a short space or without illustrations, but its simple principles may be outlined. Briefly, then, the process includes the making of two negatives simultaneously in two side-by-side cameras, synchronously operated. These two negatives are made, one by direct light through a di-chromic screen, the other by reflected light from the same screen, and both, by the use of prisms, from the same optical viewpoint. This screen is the wonder in the process, as it *transmits* red and *reflects* green light. From the resulting two negatives two prints are made, the first of which is direct upon ordinary positive film, which is then dyed with red. The second negative is then superimposed upon the dried and *resensitized* film, making a second print which comes out blue. By a chemical differentiation the first color gives not only the reds but the yellows and thus this strictly two-color process gives to the eye a three-color effect. The limitations of the process are in the slowness of printing the blue, which holds one printer's output down to about three hundred feet of film a day, and the expense, which is double that of ordinary black-and-white film. But the result is true color photography for the "movies" and Mr. Ives expects to cheapen and quicken the process to an everyday commercial standard. It has the great advantage over other moving-picture color systems that it uses standard film, a standard projecting machine, works at standard *or slower* speed, has *no* color fringes or flicker, and on account of the dichromic reflector used in place of ordinary color screens, can "take" the negatives with one-half the light (or half the exposure) used by other systems of moving-picture color photography.

Mr. Ives has invented so many systems of color photography that one rather fancies him several times a millionaire.

"Nothing of the sort!" he said, in answer to a question. "I never made much money out of any of my inventions. I am not interested in the business end of them, but in the problem. I have taken out sixty-five United States patents and many of them are in use today; but, alas, many of them lay idle until they expired and someone else has reaped where I sowed. Luckily, my pleasures are not in making money, but in doing the things which have to be done—solving the problems.

Had Mr. Ives received a fraction of a cent royalty on each square inch of every half-tone ever etched he would be so wealthy today that Rockefeller would appear poverty-stricken. When this was pointed out to

The inventor of the half-tone and of the motion-picture in color

him he smiled—he has a singularly vivid smile—and answered gently: "It's something to know that one's work has been of so much use to the world—something to be the father of the half-tone."

"What do you think of the future of color photography for the amateur?" was asked.

"There are several processes he can use, if he will," was the answer. "But he won't. They are all a little too complicated and dainty in operation. The professional uses them little because of the expense attached, which makes it impossible to do as the average sitter expects—make a half dozen negatives and give her a choice! But any system of color photography which depends upon pigments on paper, no matter how applied, is at least but a compromise. The only absolutely truthful color process is my old "kromoskop" process—and the 'man in the street' called that a fake!"

Whereupon Mr. Ives demonstrated it to me, and would there were more fakes as beautiful! The kromoskop process shows a stereoscopic picture without any structure (such as half-tone dots or stripes or other grain) in absolute fidelity to nature's colors, be they violent or subdued. But the picture is a *picture of light*, must be viewed through a special instrument, is small and, of course, cannot be framed or put in a book for the parlor wall or the living room table.

"I was exhibiting this in London shortly after I invented it," Mr. Ives recalled, "and had a number of criticisms. One was from a successful artist, who said my greens were all wrong because they were a dull brown. Another was from a successful art critic who declared my greens were too brilliant and metallic. I let them argue the matter out with each other, and, for all I know, they are arguing yet. Neither would believe what I knew to be a fact, that one was slightly color blind on greens and the other on reds! For it is an oddity of this process that it reproduces colors perfectly for the normal vision, but not for the color blind!"

"You have received some medals for your work, I believe?" I ventured.

"Yes, some. I'll show them to you if you want."

I did want. Mr. Ives went out of the room (this was in his pleasant apartment in Philadelphia) and returned in a few moments. "I couldn't find them all," he said, "but these will do."

I imagined they might. The man came in with a *tray* literally dripping cases of medals—medals gold and medals silver, medals bronze and medals something else, medals large and small and intermediate. There are *five* John Scott medals from the Franklin Institute of assorted dates and for assorted accomplishments. One is for the diffraction chromoscope, another for Rowland diffraction-grating replicas (now used all over the world and making available for laboratory use a tool of the laboratory in scarcely less perfect form than the original itself, at one-fifth the expense) another for projecting lanterns, a fourth for isochromatic photography and the fifth for the "parallax stereogram," which is an oddity of science in which an apparently single picture, looked at without any apparatus, appears in strong relief. A modification of this invention, also patented by Mr. Ives, is frequently seen in advertising novelty displays in which a picture changes as the viewpoint changes—everyone is familiar with the first smiling, then frowning youth who changes his expression, actually with your viewpoint, apparently as he does or does not use so-and-so's shaving cream!

Mr. Ives has the Royal Photographic Society's Progress Medal, the Medal of the London Society of Arts (which he had forgotten he had won until he opened the case!), the Medal of the Photographic Society of Vienna, the Franklin Institute Elliot Gresson Medal, the Rumford Medal of the American Society of Arts and Sciences, the Royal Photographic Society of Great Britain Science Medal, the J. Traill Taylor Memorial Lectureship Medal, the Franklin Institute Medal, the International Inventions Medal (London), a special gold medal from the Photographic Society of Philadelphia, the Medal of the Royal Scottish Society of Arts, an inscribed watch from the International Society of Photo Engravers, the Franklin Institute Longstreth medal, and several Exposition medals.

Speaking of expositions reminded Mr. Ives of an amusing experience he had while exhibiting in Buffalo. The kromoskop takes its pictures in ordinary black and white and exhibits them in colors by the use of reflecting and refracting color screens. An authority of the exhibition in question wished to throw the exhibit out on the ground that it was a fraud and that any photograph viewed through color screens would appear as a colored photograph! This was matched by the comments of some near-scientists, when he exhibited what he calls "freak diffraction gratings" which behave as no ordinary grating could or should. The way they were made and the peculiarities of their performance were explained to the amusement of some students of optics, who apparently thought Mr. Ives a harmless but deluded crank who had stained some "regular" gratings. However, Pro-

(*Continued on page 112*)

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

A Word for the Steam Automobile

To the Editor of the SCIENTIFIC AMERICAN:

The SCIENTIFIC AMERICAN has published from time to time descriptions of new types of steam automobiles and has likewise devoted considerable space in its correspondence columns to a discussion of this type of machine. Although the relative merits of the steam-driven and gasoline automobile have been a fruitful source of argument for twenty years, it seems to me that there are still a good many points that are not yet settled and which will bear further investigation and discussion.

I was much impressed by a letter of Mr. W. J. Parish, published in your issue of November 8, 1919, in which he gave his opinions very frankly concerning the steam car situation as it exists today though I think he magnified unduly the disadvantages of the steam car. As I have been familiar with steam automobiles for a number of years and own one at the present time, I should also like to express my views on the subject, perhaps along rather different lines from previous letters which I have read. I think that the present comparatively small use of steam automobiles can be explained by the fact that the motoring public of the present day is almost wholly ignorant concerning them. If one will go back to the early volumes of automobile journals, say along 1900 to 1902, one will find that at that time the steam machine existed on an equal footing with the gasoline car. In fact, it was probably more distinctly the American type of automobile than any other motor car then being manufactured. The steam machines built in those days were a remarkably highly developed type of automobile considering the time at which they were built. They were, however, for this very reason, considerably more complicated than contemporaneous gasoline machines with the possible exception of some of the imported French cars. Those were the days of very rapid development of the gasoline automobile and improvements were introduced almost daily. As the gasoline machines then built were very simple while the steam machines were even more complicated than the ones produced today, there was a decided swing away from the steam machine which seemed to be forgotten by a large part of the motoring public. Meanwhile the gasoline car improved in performance but only at the expense of additional complication, till in this respect it far exceeded the steamer.

A good many advocates of the steam automobile say, and I think not without truth, that if the two cars could start on an equal footing today the steam machine would soon be used in as large numbers as the gasoline.

The steam automobile at present is bought and used by people who thoroughly understand it and appreciate its many good qualities. From those I know who own this type of automobile I would say that scarcely one of them has bought a steam car with the same object in view as the average man who buys a gasoline machine. Steam-car owners are nearly always well acquainted with such machinery and are quite expert in doing their own repair work. These men can get the most out of the steam car; they know how to handle it intelligently and in case of any trouble are not dependent upon a service station. This is almost necessary in some places as today comparatively few repair men are familiar with steam automobiles. The owner of a gasoline car, on the other hand, buys one with the idea merely of running it and in the case of any breakdown taking it to the nearest repair station. I should say that fully three-fourths of the owners of gasoline cars do not thoroughly understand the mechanism and are not competent to do much repair work upon it. However, as they can always find any number of shops and garages within easy reach, they can get repair work done for them if they will pay the price.

I think that it is a mistake to try to compare the two types of cars as they are so utterly different. It is useless to suppose that a steam car, even with a flash boiler, can be built which can be started as easily as the modern gasoline car with its electric self-starter. (I refer, of course, to those times when the gasoline engine is in proper running order and will start after one or two revolutions.) Quick starting after a long period of disuse is the legitimate and great advantage of the internal combustion engine. Any boiler having a reserve capacity requires some little time to generate a head of steam from cold water. This is the disadvantage of the steam car, but I do not think it is as serious as the advocates of the gasoline machine would have us believe. After all, the times when we need a car on one or two minutes' notice are comparatively rare. The average man can nearly always tell a few minutes ahead when he will need his automobile and the length of time is generally sufficient to get up steam. If he needs a car that can start at any time on a few seconds' notice, he ought, of course, to buy a gasoline one. On the other hand, it is absolutely useless for the builders of gasoline cars to attempt to duplicate the steam car's performance as regards flexibility of control and ease in acceleration. These qualities are inherent in the steam plant and the various expedients such as gear shifts and multiple cylinders introduced on gasoline cars, are really only excuses for a type of motor which is fundamentally poorly adapted to variable speed work.

I do not attempt to argue that the gear shift, and 4, 6, 8 or even 12 cylinders have not been fairly successful. They have made the present day gasoline automobile possible, but, nevertheless, they are excuses all the same, and from the scientific point of view the gear shift is the weakest element of the whole car.

Good as the performance of the modern gasoline automobile is, considering the handicap due to the type of engine, the machine as a whole is, nevertheless, a collection of very complicated mechanisms and its reliability is really to be wondered at when one considers the amount of auxiliary equipment upon which the correct functioning of the whole machine depends. The steam car, on the other hand, is much simpler. It is true that there are valves and pipes and the burner to be looked after. All of them may give trouble, and yet it is almost impossible to "stall" a machine of this type if one or more of the parts of the power plant are out of order. Its performance on the road is so excellent that to my mind it is a strong argument for the use of such cars even when one considers their disadvantages, and these are not really serious drawbacks to any one who understands them. Before any large number of people can be induced to purchase this class of machine, they will have to become more familiar with it and with the theory of steam operation. While, as I have already stated, I think that three-fourths of the owners of gas cars do not really understand them, they think that they do, and they know that they know nothing about steam cars. The failure to educate the public along these lines is perhaps due in a large measure to the attitude of the steam car manufacturers themselves who have been content to sell their product to the few who really appreciated them without attempting to induce others to buy. Likewise, many owners of steam cars have apparently got a lot of satisfaction by giving the impression that such machines require vastly more intelligence to operate than the gasoline type which, I may be pardoned to state, is not at all the case. What is needed is familiarity with a different kind of machinery, functioning in a different way, and yet basically far simpler than the gasoline car.

There is a field, to my mind, for the steamer which cannot be filled so well by any other type of car. Likewise, there is the legitimate field for the gasoline vehicle. No argument is required today to prove that the gasoline and electric types of automobiles are both useful for certain particular purposes. Why can we not have the same attitude toward the steam machine? It is capable of doing wonderful work and for certain uses where its disadvantage, the inability at quick starting after a long period of disuse, is not a serious factor, it is the logical type to select, on account of its many other superior qualities.

Think of the great advantage of being able to burn completely and easily a cheap and heavy oil instead of gasoline for fuel! I have used both gasoline and kerosene burners and have had better success with the latter and have got greater mileage from my car. Burners can without doubt be designed to utilize even heavier fuels, and I think the time will come when engineers will be forced to recognize the fact that the solution of the automobile fuel problem is to be found in the steam car. Why go to the Diesel engine, which is even less adapted to vehicular work than the familiar gasoline motor, when the reliable and simple steam plant can be used?

I think a more friendly discussion of the subject is in order and might lead to much real good for the automobile-using public.

HUGH G. BOUTELL.

Washington, D. C.

Visible Sound Waves

To the Editor of the SCIENTIFIC AMERICAN:

In connection with a letter of mine which was published in the SCIENTIFIC AMERICAN on March 6, 1920, under the above heading, my attention has been called to the fact that there may be some misunderstanding of certain statements made therein.

I referred to recent studies by Professor Sabine in connection with photography of sound waves and stated that his perfected apparatus was the result of several years of patient and skilful development. I did not wish to detract from the work of those others who have labored on the same subject and by whose studies Professor Sabine was able to profit. Professor Sabine called his method "A Modification of the Toepler-Boys-Foley method of photographing air disturbances."

Professor Arthur L. Foley of the University of Indiana, has done especially fine work along this line and my attention has been called to the fact that the SCIENTIFIC AMERICAN for February 15, 1913, published a number of excellent photographs taken by Professor Foley.

The development work done by Professor Sabine has resulted, in the opinion of the writer, in a method of photographing sound waves which is appreciably more satisfactory for the problems involved in architectural acoustics.

I hope you will give space to this letter in an early issue, as the writer does not want to have his letter convey the impression that Professor Sabine was solely responsible for the development of the modern methods of sound wave photography.

WM. H. CAPEN.

New York.

Duluth to Liverpool

To the Editor of the SCIENTIFIC AMERICAN:

I have read with interest Mr. Skerret's article under the above title, which is an admirable statement of the project, and the reasons for it as we understand it.

I note your editorial in the same issue. I agree with you. New York should develop the Barge Canal to the fullest possible capacity. The West wants it and will use it for all it is worth.

The West wants all the service it can get from the railroads by any possible expansion of their facilities. It wants all the relief it can get from the present intolerable situation by the services of the Barge Canal, and it wants an entirely new outlet that it may have leave to grow according to the measure of its capacity.

What can the railroads do? Give them all the money they can spend. Give them carte-blanche—and in ten years they will have caught up with today's necessities. The West, meanwhile, is eager to expand its production. It looks as though the West must wait.

Perfect the Barge Canal. Work it to its capacity. The most it promises is a carriage of ten million tons a year eastbound. When the New York people proposed the Barge Canal as an adequate measure of relief, they remind me of the innocent gentleman of Boston who asked, "What is the matter with the Hoosac tunnel?"

Within four years from the time when Congress may act they can have relief through the lakes-to-ocean route. We can get relief in quicker time in the present emergency by this measure than by any possible improvement in the railroad situation. We can get adequate relief by this means where the Barge Canal will only allow a little trickle of traffic.

By all means let New York make the most of the Barge Canal, but do not make the fatal mistake of imagining that the country between the Alleghanies and the Rocky Mountains can find in that narrow channel an adequate outlet for the production, of which it is capable.

We welcome your views. I am sure that a further study of the intolerable conditions under which all these states suffer will bring you to a point of view identical with ours.

C. G. HARTLEY.

Duluth, Minn.

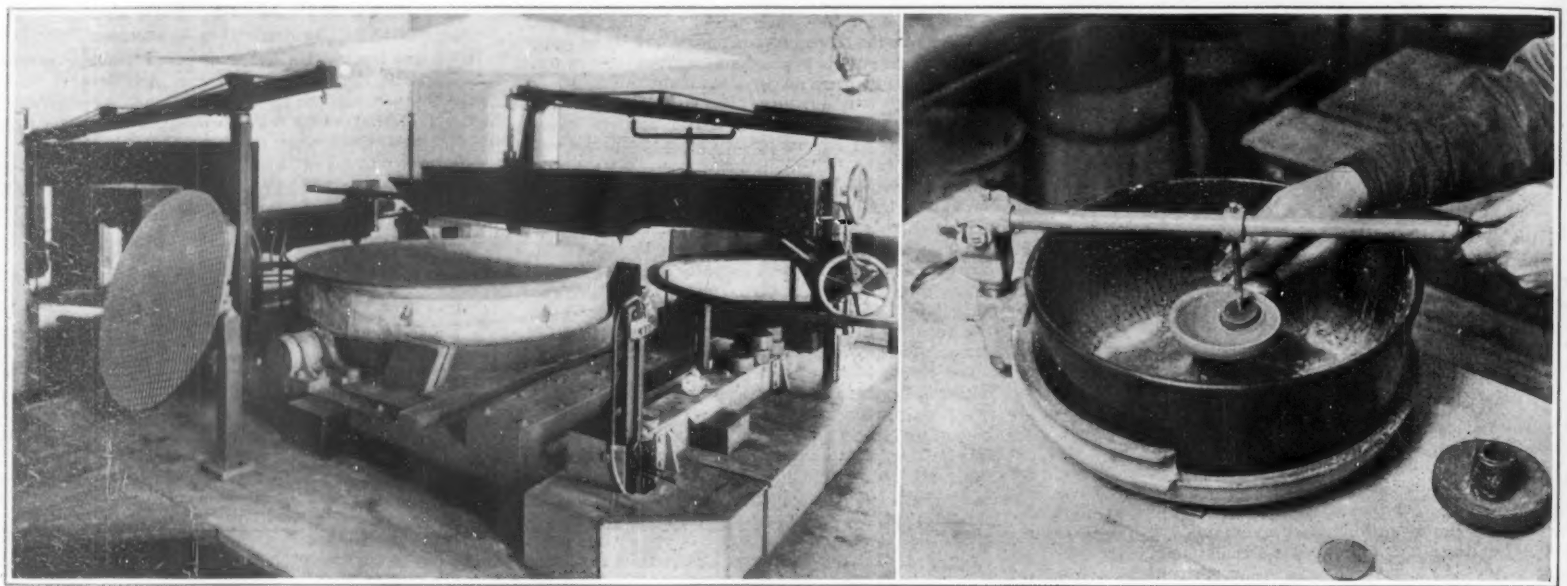
Saving Shoes

To the Editor of the SCIENTIFIC AMERICAN:

I read in a recent number of vaseline applied to shoe soles to save wear. I believe a better remedy which I have used a long time is boiled linseed oil. Saturate the sole. Makes it hard as rock.

CHARLES A. WHEELER.

Los Angeles, Cal.



Left: The 100-inch mirror for the Hooker telescope on the grinding machine ready for concaving. *Right:* Finishing and surfacing a lens

Two phases in the manufacture of huge and small reflectors and lenses

Our Mechanical Eyes

Glass for Optical Purposes, and How It Is Made

By J. F. Springer

WE are so familiar with glass objects and the material enters so into our every day life that it would be difficult mentally to reconstruct the world and visualize what our present civilization would be without it. And yet, the ancients either didn't have glass or had it only in a restricted way. Near the beginning of the Christian era, glass became known to the European world. The ruins of Pompeii, which was overwhelmed in 79 A. D., have yielded examples of small window panes. In these same ruins was found a plano-convex lens, presumably of glass. As lenses may be, and have been, made of rock crystal and other transparent substances, it would be unsafe to conclude that the ancient existence of a magnifying lens means a contemporary knowledge of glass. From the ruins of Nineveh, a city destroyed about 600 B. C., has been recovered what is probably the oldest known lens. It is plano-convex and is of rock crystal. It is not quite round, measures 1.6 x 1.4 inches on its axes and is 0.2 inch thick. Its refractive power is 10 diopters. This and other old lenses are, it seems, all of them of the convex class—thicker in the center than elsewhere. Pliny and Seneca, both of the first Christian century, tell us in effect that the Greeks and Romans were well aware that a glass globe filled with water produced a magnifying effect.

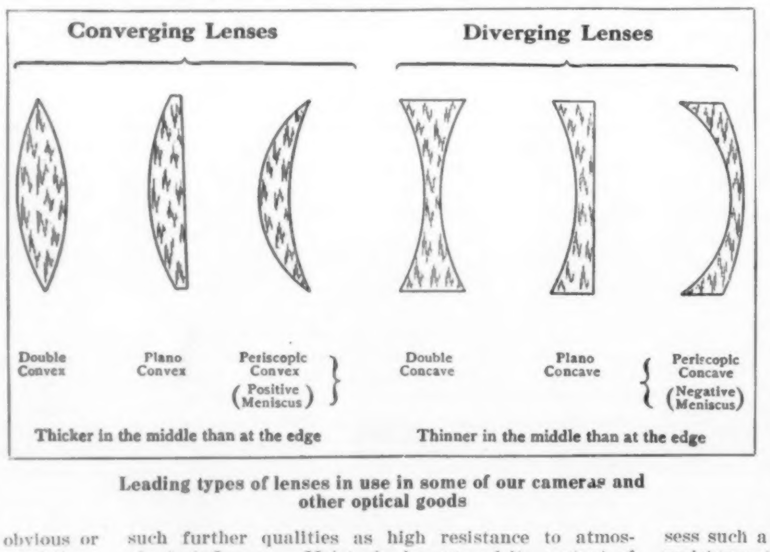
In our own days, glass objects are everywhere. Optical applications are very familiar. In fact, the number of spectacle lenses in actual, everyday use is enormous and their manufacture has become a very considerable department of industrial activity. Glass is used for giant lenses in our big refractive telescopes and in the construction of still larger reflecting mirrors used in certain great telescopes.

The reasons for the supremacy of glass in optical manufacture are, some of them, obvious or nearly so. Its wonderful transparency is one of these reasons. Its homogeneity is another. Then it may be molded or otherwise simply fashioned to approximate form and finished by grinding processes to an exactitude well-nigh inconceivable.

The small lenses used in spectacles and eye-glasses are made in enormous variety. Those required for big and little telescopes and for similar instruments greatly increase the ranges of variation, both in form and size. Nay, in optical matters, glass is not simply glass. There is, in fact, a big variety in the material itself.

In general, optical glass falls into two classes—lime glass and lead glass. The lime glass should, however, not be the usual thing used for ordinary bottles, window panes, etc., but a very clear variety. It is then called *crown glass*. Lead glass, often termed *flint glass*, is invaluable for special optical purposes. It may be made so as to possess a very brilliant luster, a high specific gravity, a high refractive index, and other good qualities. The two types of glass, lead and lime, may be conjoined for the purpose of securing optical results that are not readily possible with either alone.

One of the leading manufacturers of optical lenses says, in effect, that there is no glass in existence which possesses all the desired qualities in the highest degree. Clearness and responsiveness to molding operations are highly desirable. But optical requirements impose such further qualities as high resistance to atmospheric influences. Moist air, because of its content of carbon dioxide, acts upon glass surfaces by way of reducing brilliancy and transparency. Glass exposed to the air becomes more or less tarnished or coated, and the alkaline content at and near the surface is dissolved out, leaving silicic acid in the form of fine scales or flakes. These are naturally no longer glass.



Leading types of lenses in use in some of our cameras and other optical goods

The optical manufacturer can naturally have glass made to any specifications; but Nature herself hinders him. Lead and lime glass are so called because the one contains lead oxide and the other calcium oxide. Some silicate (as sand or quartz) and some such alkali as sodium, potassium or Glauber's salt are used in both. Now, the more silicic acid and calcium oxide that are present, the greater the resistance of the glass to atmospheric influences. But these substances, upon being increased in relative quantity, add to the infusibility. It is difficult to produce a hard and resistive glass that shall at the same time be pure. All increase in the alkaline content gives added fusibility, but it lessens the resistance to the air. Because of considerations of such character, the manufacturer takes a middle course.

Glass melts in the neighborhood of 2,700-2,900 degrees Fahrenheit. This is a considerable temperature, and the manufacturers are understood to resort, generally, to the Siemens regenerative system in the construction and operation of furnaces. A proper mixture of sand, calcium, and alkali is thrown into a red hot crucible. The mass immediately boils and ferments, carbon dioxide being evolved out from the seething liquid. From 18 to 30 hours is devoted to the melting. When the melt cools to a fairly low temperature, it is found to be viscid and suitable for manipulation.

Spectacle glass is ordinarily formed first in the shape of big cylindrical shells. These are cut parallel to the axis, reheated in a special oven, and then flattened upon a table with the aid of a long rod manipulated by the hand or with the assistance of some equivalent means. Next, the flat sheet goes into an annealing oven where it cools off by slow degrees. The thickness of the sheets is controlled by the amount of soft glass that comes away with the long iron tube when the latter is withdrawn from the molten mass in the crucible. Uniformity of thickness is another matter and requires skill and experience on the part of the glass blower.

Spectacle glass must naturally be clear. It must also be uniform and must possess such a degree of hardness as not to scratch. The resistance to air must be good. The fumes from concentrated muriatic acid when applied to glass afford a recognized test for excellence of quality, especially with respect to air-resistance. With lead glass, the crucible is covered, for the reason that otherwise the contact of the furnace gases with the lead results in a discoloration of the glass. In general, modern glass furnaces are heated exclusively by gas, this gas being made from coal, wood, or some other suitable material. If colors are desired, they are obtained by the addition of the proper metallic oxide to the molten mass. Cobalt oxide produces blue; chrome oxide, green; copper oxide, blue-green; but copper protoxide,

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Learning by Seeing

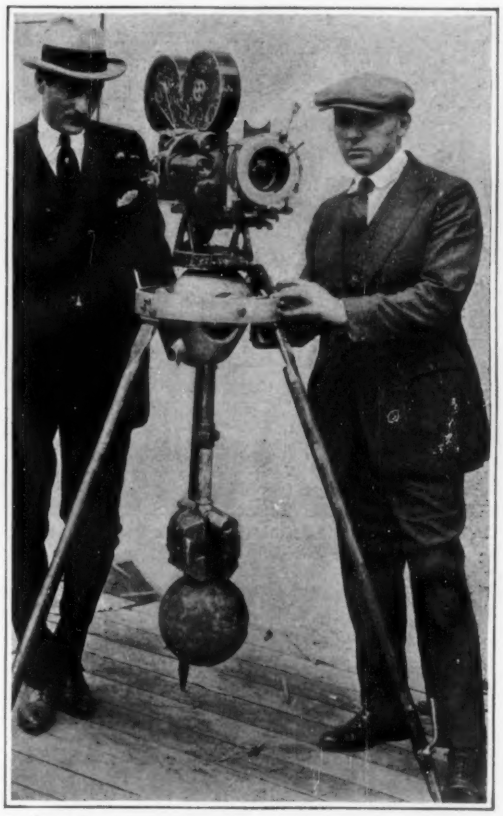
By George H. Dacy

MAKING practical application of the "Seeing is believing," slogan, the Bureau of Commercial Economics, Washington, D. C.—the greatest distributor of educational motion picture film in the world—is, at present, rotating its film resources of 35,000,000 feet of negative contributed by thirty different countries so that the pictures are exhibited to 2,000,000 people every twenty-six days. The ramifications of this unique organ of education are now so numerous and worldwide that it is possible to provide all portions of the globe from the frigid Arctic Circle to the plains of Senegambia and the steppes of Russia through 3,600 distributing cities with a change of "movie" film every week, supplied from over 100 film exchange centers operated by the organization.

The Bureau of Commercial Economics is an altruistic association which utilizes the facilities and instrumentalities of governments, manufacturers and educational institutions in the universal dissemination of useful information by the graphic method of motion pictures which are always displayed to the audiences free of charge. The free "movie" shows are held at universities, colleges, technical and agricultural schools, public libraries, state armories, community centers, state granges, settlement houses, missions, chambers of commerce, boards of trade, rotary clubs, fraternal institutions, welfare clubs, factories and wherever the people are interested and crowds can be assembled. Thirty-six specially equipped motor trucks provided in each instance with a powerful projector, an electric generator, a field phonograph and a collapsible screen are operated in carrying the motion pictures to the rural communities both in America and foreign countries.

Educational films—supplied by industrial, scientific and commercial enterprises as well as by the railroads—which portray every conceivable operation from controling a forest fire to making an automobile, from manufacturing pins to building locomotives, are distributed. Films are sent at regular intervals on dog sleds from Newfoundland to the Arctic Circle over a route which covers 2,100 miles. By means of portable projectors and small lighting generators, the Esquimos, lumber jacks, fishermen and prospectors of this northland country are regularly entertained—often in the ice-built huts of the natives or the crude shelters of the whites—with motion pictures which bring the doings of the outside world to these pioneering peoples.

Primitive carts drawn by oxen are used as the means of transportation in conveying the films and motion picture machines to the inland villages of the Dutch East Indies, while throughout the Orient the camel is occasionally harnessed as the beast of burden to carry the current events as depicted in pictures to the various tribes and creeds of the desert. The Hindoos of India enjoy the same "movies" which delight the natives of Peru, Chili and Bolivia; these get the applause of audiences of Inca and Hopi Indians as well as those of local assemblages in every state in the United States and every province in Canada. To Australia, South Africa, China, Japan, Russia, England, France, Italy, Denmark, Sweden, Norway and to every quarter of the earth where the motion pictures have



An ingenious arrangement of gimbal rings and heavily-weighted pendulum serves to keep the motion-picture camera on an even keel

penetrated, the "teaching-by-eye" films of the Bureau of Commercial Economics are now disseminated.

For a period of eighteen years, Dr. Francis Holley, formerly a builder of trans-continental railroads, was blind, due to paralysis of the optic nerve. During this time he traveled all over the world, visiting various eye specialists in hopes of regaining his vision. Ultimately he decided if ever his eyesight were restored that he would devote the balance of his life to making the world at large see things. Finally, by the use of high frequency electric current treatment, Dr. Holley's vision was restored, although as a consequence of the electrical treatments his lower limbs were paralyzed. He has made good his vow to carry visual education to the masses, he being responsible for the organization and success of the Bureau of Commercial Economics.

Nearly a score of years ago, Dr. Holley conceived the plan of teaching industrial workers concerning complicated operations in their respective factories by the use of films. Under his direction the first educational motion picture ever made was filmed in one

(Continued on page 116)

Keeping the Camera on an Even Keel

By J. E. D. Meador

DESIGNED to overcome the effect of the camera's tilting while taking motion pictures on a ship's deck at sea, which makes the skyline appear to rise and fall, a device patterned after the marine gimbal has been constructed and employed by a motion picture company with excellent results.

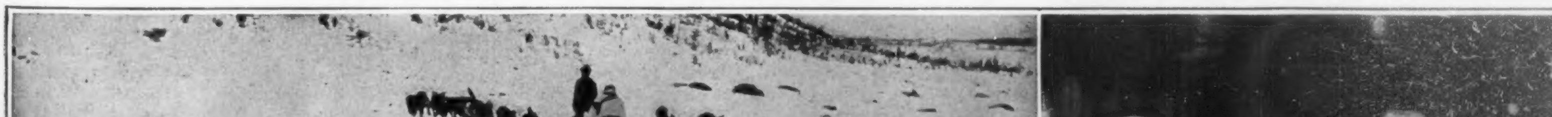
The accompanying illustration clearly depicts the new idea. The camera resting on aluminum gimbals and, equipped with ball bearings, may be turned completely around without moving the tripod. The legs are made of 1⅜-inch steel tubing, the lower ends being fitted with adjustable pointed tips. The pendulum, an iron ball, with auxiliary weights, suspended by 1½-inch pipe, measures 34 inches in length. The ball and weights aggregate 150 pounds. To facilitate carrying, the ball has a cross pipe through it to serve as handles. With camera loaded the complete outfit weighs about 250 pounds. The tripod legs can be adjusted to give the camera an elevation of ten feet.

The gimbals were manufactured in New York from plans and embody several new ideas. A severe test that included exposing several hundred feet of film, while the camera was vigorously rocked, proved the device a success. The designer has taken steps to secure patents covering the most important improvements embodied.

Telephoning in Cipher

EVERYONE probably has felt an uncomfortable fear, at times, that a private conversation over the wire was being listened to by an unbidden and unwelcome third party. Such listening in, in fact, is quite possible even on a private wire and many are the instances where information thus gained has figured in divorce courts, criminal cases, or the game of politics. In time of war, of course, such betrayal of guarded secrets may become a matter of life or death. Various methods have been employed for preventing such leakage. One that has been recently made known is the invention of a young French physicist, M. Poirson, attached to the laboratory of General Ferrié.

When vibratory currents are interrupted audition is greatly interfered with. In making experiments suggested by this fact, M. Poirson obtained surprising results. He found that if the current be interrupted with a frequency varying from 100 to 125 the voice is altered, becoming harsh and strident. When 125 to 170 interruptions are produced one hears a little better. With 210 to 270 interruptions the voice is once more greatly altered, but beginning with 290 interruptions communications are much better heard. These experiments suggested to the investigator the idea of replacing the interrupter by an inverter of the current. Rapid inversions modify the harmonic composition of telephonic currents and currents thus deformed become absolutely unintelligible over the telephone along the entire length of the line, producing upon the ear the impression of some weird unknown language. At the receiving end the telephonic currents thus interfered with are reëstablished in their normal order by inversions which are identical and synchronous with the former ones. The apparatus has been named the cryptophone.—By *M. Tevis.*



1. A movie outfit in the Arctic Circle that travels a circuit of 2100 miles. 2. A motor-truck picture show that was exhibited to 65,000 people in one evening at Washington. 3. Interior of one of the motion-picture trucks, showing phonograph, generator and projecting machine

The perambulating film that educates while it interests

Start of first race. Photograph taken from Committee Boat at one end of starting line

The America's Cup Races

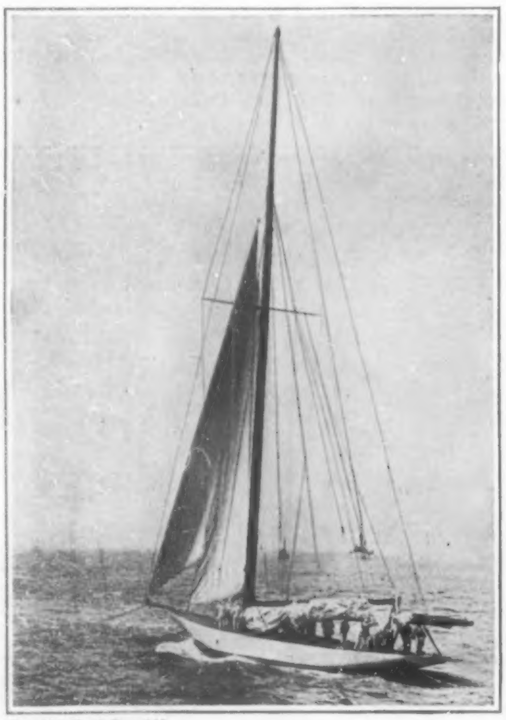
Notes on the Contests for 1920

By J. Bernard Walker

MANY people who witnessed the present series of races for the America's Cup have asked why the yachts did not sail "boat for boat," instead of one having to make the other the enormous allowance of over seven minutes—a handicap which would represent, at the maximum speed of these craft, nearly a mile and a half of distance.

The practice of granting time allowance to a smaller boat was long ago recognized as necessary for the encouragement of yacht racing. For size means speed, and, boat for boat, unless there is something radically wrong with the design, the larger craft will beat the smaller. So, gradually, a system of handicapping grew up, in which time penalties were imposed upon either waterline length, or beam, or draft, or sail area, or upon various combinations of these elements; and efforts were made to formulate a rule which would be so nicely adjusted as to give the smaller yachts an even chance of picking up a fair share of the cups in a season's racing.

It is because Herreshoff in designing "Resolute" aimed to produce a small, fast boat, and Nicholson in "Shamrock IV" aimed at a faster big boat, that the "Shamrock" has to carry the burden of a seven-minute handicap. The official measurements show that she has about 20 per cent more sail area—she pays about 5½ minutes for that. She is of a fuller form in the overhangs and is more than half an inch overdraft, and another minute and a half, more or less, of penalty is paid for these.



First race: "Resolute," leading, carried away throat halyards and was towed home

But, outside of the penalties imposed by the rule, there are others exacted by the inexorable laws of nature. For the official measurements show "Shamrock" to be some six tons heavier than "Resolute"; and it takes but a glance at her profile and midsection to see that her total wetted surface is far greater than that of the smaller boat—possibly as much as 15 per cent greater.

Now it takes a certain amount of power to carry that six tons of extra weight around a thirty-mile course, and it takes a large amount of power to overcome the skin friction of that 15 per cent excess of surface in contact with the water.

So it will be clear, we think, that in addition to the seven minutes handicap imposed by the rule, the "Shamrock" carries a self-imposed handicap, due to greater weight and wetted surface; elements that are inherent in the design.

Since the extra weight of "Shamrock" is comparatively negligible in its consumption of power, the question resolved itself into one of whether "Shamrock's" big sail area could beat "Resolute's" small wetted surface plus "Resolute's" big time allowance.

Thus far, the races that have been sailed indicate that in 30 miles of reaching "Shamrock" might save her time; that in 30 miles of running she would be beaten by two or three minutes; and that in 30 miles of windward work she would be beaten boat for boat by four minutes, or eleven minutes corrected time.

These estimates are based upon close personal observation of the two boats in the three races which have been sailed at the present writing; and it is scarcely necessary to add that the weak point of the challenger, in a comparison with "Resolute" is her windward work. Whether close-handed, reaching or running, she foots faster; but when sheets are tightened in for a turn to windward, "Shamrock" does not point so high, and though she foots faster, she does not pull out far enough to compensate for the leeway.

Whether the difference is due to a certain lack of balance in "Shamrock," or whether the ocean swell which has been prevalent so far, and has caused her flat forward overhang to pound heavily and throw her head off to leeward, is an open question. Probably she would show better windward work in a calm sea.

In the first race (15 miles to windward and return) the wind was fluky. "Resolute," however, demonstrated her superiority in windward work; but just before she reached the outer mark, her throat halyards parted, putting her out of the race. As these races are considered by the Cup Committee to be a test of good construction as well as of speed, the first race went to "Shamrock IV."

In the second race (triangular, 10 miles to the leg) the boats made a good fight of it in the light wind until near the first mark. Here "Shamrock" ran into a calm, while "Resolute," to windward, sailing in a favorable streak of wind, turned the mark and pulled out a lead of several miles before "Shamrock" found the same breeze. This race was called off because of the expiration of the time limit.

The third attempt was a race. "Shamrock" having the weather berth, carried a better wind, and this, coupled with excellent handling by Mr. Burton, put her around the first mark about 3½ minutes in the lead. In reaching to the second mark she gained another 5½ minutes, and she added one more minute in the ten-mile run, with spinnaker, to the finish, winning by 9 minutes 27 seconds actual and by 2 minutes and 26 seconds corrected time.

In this race "Shamrock" showed herself to be very fast in light weather with sheets started.

The situation now looked rosy for Sir Thomas Lipton. To win, "Resolute" must take three straight. If she lost a race, the cup, after 69 years' absence, would return to British waters.

The four races, finished or attempted, had been sailed in light airs—it remained to see how the boats would compare in a good, steady, wholesail breeze. The opportunity came on Wednesday, July 21, over a windward and leeward course of 30 miles. The predictions of those who had witnessed the earlier races were fulfilled. "Resolute" pointed higher and "Shamrock"

(Continued on page 116)

"Resolute" about to round second mark in triangular race, which was unfinished for want of wind

The Heavens in August, 1920

The Mechanism of the Tides, and How Their Heights and Times Are Predicted

By Professor Henry Norris Russell, Ph. D.

MANY of our readers who are living for the summer, at least, beside salt water—as is the present writer—have doubtless been more or less careful observers of the tides and their phenomena. The main facts are so familiar to us that we hardly realize how remarkable they seemed to the Greeks and the Romans. Accustomed only to the almost tideless waters of the Mediterranean, those travelers of classic times who went so far afield as the shores of the Persian Gulf or the English Channel were amazed to see the waters retreat, sometimes for miles, across the sandy or muddy flats, and return, a few hours later, to fill all the space that they had left bare. They soon learned from the inhabitants of these coasts, and confirmed by their own observation, that these successive high tides came a little more than twelve hours apart, so that on each successive day the high water was about an hour later; that the low water came about half way between the high tides; that on and about the times of new and full moon the tides rose unusually high, and fell exceptionally low; and that when the moon was in her first and last quarters they neither rose so high nor fell so low as usual.

At about this point knowledge remained stationary for many centuries, through lack of any proper understanding of the cause which lay behind the strange change in the level of the sea. It was indeed clear that the moon must have something to do with the matter; but the nature of the connection necessarily remained unknown until Newton, by his discovery of the laws of gravitation and of mechanics, illuminated this very dark place.

Everyone knows now, of course, that the tides are caused by the attraction of the moon upon the waters of the sea; and most of us know too that the efficient cause is not the whole attraction of the moon, but the difference between the moon's attraction upon the whole solid mass of the earth and on the water of any given part of the sea. These two forces are not equal in amount or parallel in direction; and hence there is usually a small differential effect, which tends to tilt the otherwise level surface of standing water, now in one direction and now in another. In a small circular pond of still water, the level would rise at the side nearest the moon, and fall correspondingly on the other side, provided the moon was above the horizon—otherwise it would be highest at the side opposite the direction of the (invisible) moon. As the moon swung around the sky from east to west, the high tide on the edge of the pool would follow it. It would be highest when the moon was 45 degrees above or below the horizon, and would disappear when the moon was rising, setting, or directly overhead or underneath. It is not worth while, however, to look for such tides in a garden pool, for the greatest rise of the water in a pond 200 feet in diameter would be about one ten-thousandth part of an inch. By using long lines of pipe, buried in the ground and half full of water, Professor Michelson has succeeded in getting rid of the disturbances due to wind and weather, and measuring these changes in level with surprising accuracy.

Little Tides and Big Ones

In a lake 200 miles across the tide would rise half an inch above the mean level and fall as low, giving a range of an inch. Tides of this sort have been detected in the Great Lakes by taking the average of readings of the water level on many days, at the theoretical time of high and low tide, and so eliminating the effects of wind and weather, which quite overwhelm the minute tides on any given day, but "average out" in the mean of years of observation. In the land-locked seas like the Mediterranean the tides are of much the same nature, and have a range of but a few inches, except in a few abnormal regions.

In the great oceans the effects are larger and far more complicated. The oceans cover such large parts of the earth's surface that the tidal forces acting on different parts of them at the same time are quite different, and the continuous changes due to the rotation of the earth add to the complications. Even so, the time and height of the tides might be predicted, if the ocean basins were of uniform depth and regular shape; but they are actually so irregular in form and depth, and so much obstructed and cut up by continents and islands, that a complete mathematical discussion of the motions of their waters is hopeless.

This much, however, we know. The moon comes back to (approximately) the same position, as seen from any given spot on the earth's surface, at regular intervals of 24 hours and 51 minutes, which we may call lunar days. At any given part of the ocean, therefore, the tidal forces due to the moon repeat themselves at this interval—running through their changes twice, once when the moon is above the horizon and once when she is below. The rise and fall of the tides must necessarily follow suit, and so the waters of the ocean will be set swinging, rising and falling twice in the interval of a lunar day. These oscillations are very similar in character to those that may be set up in a tub of water by raising one edge slightly at regular intervals, and, as in the simple case, the water rises in some places and falls correspondingly in others at the same time. If the period of the "impressed force" is very nearly that in which the water would naturally swing back and forth from one side to the other—whether of the tub, or of the ocean if left to itself—a small impulse, often repeated, may build up a very considerable oscillation of the water.

At 11 o'clock: Aug. 7.
At 10½ o'clock: Aug. 14.
At 10 o'clock: Aug. 22.
At 9½ o'clock: Aug. 29.
At 9 o'clock: Sept. 6.
At 8½ o'clock: Sept. 14.
At 8 o'clock: Sept. 21.

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on August 7, etc.

NIGHT SKY: AUGUST AND SEPTEMBER

The tides therefore have a much greater range in some parts of the ocean than in others, and the time, as well as the height, of high water will vary from place to place; but the *interval* between successive high waters will be always exactly one-half of a lunar day.

The sun also gives rise to tidal forces, but owing to its great distance these are less than in the case of the moon and the corresponding solar tides are of smaller range. The interval between successive high waters for the solar tides is of course exactly twelve hours. They will therefore alternately get in step with the lunar tides, reinforcing these, and out of step, partially counteracting them. The former of these effects will evidently occur at the time of new moon, when the sun and the moon are close together in the heavens and are pulling on the sea in the same direction. It will also happen at full moon, when the solar tide has gained half a day on the lunar tide, and reinforces the other high water. At both these times, therefore, we get the spring tides, of large range; while midway between, at the quarters of the moon, we get the smaller neap tides.

Further Complications

The principal characteristics of the tide are thus explained. To make predictions for any given port, we must find by observation at what hours of the lunar day (measured from the moon's meridian passage) the lunar tide is high and low, and how great is its range; and also, by comparing the spring and the neap tides, what is the range of the solar tide and at what hour of the day it is high. We may then proceed to predict the tides in future for this port, and should get fairly good results.

For example, the distance of the moon changes during the month, being five or six per cent less than the average when she is in perigee, and correspondingly greater in apogee. The tide-raising force varies inversely as the cube of the distance, and so goes to fully fifteen per cent on each side of the mean, being greatest at perigee. The height of the lunar tide changes correspondingly, and the time of high tide is also influenced, since the lunar days are longer than the average when she is in perigee and moving fastest in the sky, and are shorter near apogee. These effects can be represented by superposing upon a uniform lunar tide of the average range, another tidal oscillation also of uniform height but of period a little longer than the first, so that it gets into step with the other and reinforces it every time the moon comes to perigee, and is out of step with it and diminishes its influence half-way between, when the moon is in apogee.

Again, the two high tides of the same day are not always equally high, nor the low tides equally low. The reason for this is that when the sun, for example, is far north or south of the celestial equator, his altitude above the horizon at any given hour of the day will not be the same as his depression below the horizon at the corresponding hour of the night. The tidal force in the two cases, though nearly in the same direction, will be unequal in amount, and one high water will be higher than the other. Exactly similar effects occur in the case of the moon, and we have a "diurnal inequality" in the tides. This may be represented by combining with the principal solar tide, of period half a day, a subsidiary tide of period a whole day, which, for example, is always high at the time of one of the semi-diurnal high tides, increasing this, and low at the time of the other, decreasing that one. The lunar tides are treated in the same way. And to account fully for all the changes in the tidal forces, a good many more of these minor oscillations must be added—most of them, however, small.

If the height of the tide has been observed at a given port, at regular intervals—preferably every hour, by some automatic gage—for a year or so, it is possible to disentangle from the records exact information regarding the heights and phases of each one of the twenty or thirty minor tides (each one recurring with exact uniformity), whose combination represents the actual situation. By calculating the height of each of these tides, and adding them all up, the actual course of the tides can be predicted years in advance with surprising accuracy. This would be an appalling task if it should be attempted numerically; but it can be done mechanically by a very ingenious and complicated machine which only requires to be set suitably at the start in order to run off a curve on a long slip of paper which shows the whole course of the tides for a year. Such a machine is used by the Coast Survey in preparing the tide tables which they publish for the

(Continued on page 116)

The Service of the Chemist

A Department Devoted to Progress in the Field of Applied Chemistry

Conducted by H. E. HOWE, Chemical Engineer

Water-Resisting Casein Glue

RESULTS from a series of experiments undertaken at the Forest Products Laboratory under the auspices of the Army and Navy have now been made public, and the casein glue, which has been developed there for airplane construction, should find rather wide application in industry. It has been determined that formaldehyde, sometimes used to coagulate casein, is not successful in rendering the product less soluble. All caseins, if reasonably pure, can be made into satisfactory glues, using the same formula but varying the amount of moisture. The most essential constituent used in casein to produce the water-resisting glue desired is lime, but the purity of the lime is not a determining factor. It is desirable, however, to use lime of known analysis and in employing new raw materials, tests of the water-resistant qualities of the glue produced should be conducted.

Casein is combined in its natural state with lime, from which it is freed by precipitation from milk, skimmed milk being the best source. The casein is not soluble in water, but is made into a paste with a solution of caustic alkali, and when the mixture dries, it is insoluble in water. Proof of the value of casein glue, as well as animal, vegetable and blood albumen glues, has been shown by subjecting samples to the action of gasoline, engine oil, and castor oil for twenty weeks, after which no separation of the plies was evident.

Complete information on this subject in the Technical Notes of the Forest Products Laboratory.

Ang-Khak

ANG-KHAK is a red rice which is the source of a common vegetable color used in Chinese food products. The color is produced by certain strains of a mold, which spreads throughout specially treated rice kernels. The same fungus has been found in American corn, in silage, and is accountable for "freckled" salt fish. The finished Ang-khak is composed of clear-cut grains of a dark red color, which may be easily reduced to a fine, soft, red powder. The mold must be grown under controlled conditions, with particular attention to water content, which, if incorrect, will produce a grain which splits into fragments rather than breaking down to a powder. It is necessary to select proper strains of the mold, *monascus purpureus.*

Tunnel Atmosphere

THE Bureau of Standards has been requested by the New York and New Jersey Vehicular Tunnel Commission to undertake an investigation of the atmospheric conditions which would be likely to exist in such a tunnel as is projected to connect Manhattan Island with New Jersey. In this study particular account must be taken of the exhaust gases from motor vehicles, in which, as is well known, carbon monoxide is to be found. Road tests have been begun with some eighty motor vehicles of different classes, and the results obtained from these tests differ somewhat from the block tests which have heretofore been conducted. In the near future a series of chamber tests on human subjects will be started and these chambers will be designed to represent cross sections of the tunnel as it is now designed. Inasmuch as there are similar tunnels under consideration for other cities, the work in question assumes increased importance.

Empire Cotton Growing

IT will be enlightening to those interested in cotton to follow the efforts of the British Empire Cotton Growing Committee in increasing the supply of suitable grades of cotton fiber. The committee is of the opinion that within the British Empire both the quantity and quality of cotton required can be produced, and it is toward Egypt and the Sudan that they look for the most immediate large increase in the production of cotton. The African continent is looked upon as most promising, but before any considerable area can be brought into cultivation, large sums must be expended on irrigation, drainage, railways, water-ways, roads, and harbors. There is also need for greatly increased staffs of agricultural specialists and government control of seed supply, as well as of measures to combat insect pests. At this time, when the possibility of establishing an American Institute for Cotton Research is under consideration, it is well to note that the Empire Cotton Growing Committee places a central institute, in which all the sciences relating to cotton growing may be studied, as one of their first recommendations.

It may be that the time has come when much of the tropical and semi-tropical land may be brought under cultivation, for whereas this development could not go forward when the horse had to be depended upon as the only power for cultivation, the condition is changed by the advent of the modern tractor. The motor is also capable of bringing the crop to the avenues of travel, and in all of these agencies for the spread of civilization and increased production, chemistry has played an important part.

Specifications for Basic Sulfate White Lead

CIRCULAR No. 85 of the Bureau of Standards has been issued, being a specification for basic sulfate white lead, prepared by the inter-departmental Committee on Paint Specification Standardization. With the various departments interested there were associated representatives of the Paint Manufacturers' Association of the United States, and prior to the publication of the specifications, a number of paint and varnish makers, including all of the large manufacturers of white lead, were asked to comment upon the poposed requirements.

The specification gives chemical and physical requirements of dry basic sulfate white lead and basic sulfate white lead ground to a paste in linseed oil. Methods of sampling and methods of testing both dry pigment and the paste are part of the specification.

Energy Requirements

A WEEKLY news letter of the U. S. Department of Agriculture states that a family, consisting of a father, mother, and three children requires approximately 12,000 calories per day, and that the diet is best balanced by considering 120 units of 100 calories each. On this basis, fruits and vegetables should supply 24 units; milk, eggs and meat, 36; cereals and legumes, 30; sugar and starchy foods, 12; fats and fatty foods, 18.

Desiccated Vegetables

DR. HAWK, of the Jefferson Medical College, points out that when desiccated vegetables are immersed in water for a few hours they assume a form very closely approaching that of the fresh vegetable, and that if this rehydrated material be removed from the water and left at room temperature for 24 to 36 hours it returns to approximately the same anhydrous state as before being freshened. This is an entirely different behavior from that observed in fresh vegetables, and the conclusion is reached that there must be a structural difference. The failure of the re-hydrated product to retain its water may be due to the change in the colloids of the vegetable cells, with an accompanying decrease in their power to hold water. The decrease in the inhibition power of the colloids might be due to the removal of mineral salts from the vegetable during soaking in water. These experiments have no reference to nutritive values.

Physical and Chemical Properties of Copper

AT a recent meeting of the American Institute of Mining and Metallurgical Engineers there was a discussion of the relationship between the physical and chemical properties of copper, particularly with reference to the indication of chemical composition which certain physical characteristics indicate. Thus the appearance of the surface of the copper when cooled is termed its "pitch," which is the general contour of the surface of the shape, and this may vary from concave to convex. When the surface is concave, it is called a low pitch, and a convex surface is a high or tough pitch. A level surface is called a flat pitch. In the trade they go further and designate as the "set" the detailed appearance of the surface, that is, wave-like structure, and high pitch copper is usually described in terms of the set. If the set is very close and even, the copper content is about 99.95 per cent, and this same close set cannot be produced on a shape of low pitch.

Good electrolytic copper should have the following analysis, approximately: copper, 99.95; silver, 0.001; oxygen, 0.039; sulfur, 0.003; arsenic, 0.0015; antimony, 0.0020; nickel, 0.0015; iron, 0.0025; lead and bismuth, nil; selenium and tellurium, trace.

Standard Materials

THE verification of analytical methods, the standardization of calorimetric work, and the determination of melting-points and similar scientific work depend very largely upon standard materials. For some time the Bureau of Standards has made a practice of supplying many thousands of samples annually, embracing iron, steels, ores, and organic compounds, upon which a great deal of work has been done, and with each a certificate was furnished for the guidance of those who depend upon them for their standards. This work has been made possible by appropriations, but the sale of samples has returned to the United States Treasury a larger sum than it has cost.

We have then a unique case, in that the work, besides being of fundamental importance to industries and educational institutions, is also self-supporting. It has been somewhat of a shock, therefore, to note that the House Committee on Appropriations has failed to provide any money for continuing this work, whereas a somewhat larger sum had been requested in order to extend this important activity. The failure to make suitable provision must be due to a lack of appreciation as to what these standard materials mean to industry, and it is hoped that active steps can be taken to insure the restoration of the item in question.

Ceramics

DURING the recent meeting of the American Ceramic Society 131 papers were presented and many of these report results of scientific studies on the several problems peculiar to the various divisions of the Society. The field embraces enamels, glass, refractories, terra cotta, white ware, porcelain and kilns.

The point was made in some of the discussions that the day when scientific work was unappreciated in the industry is rapidly passing, and those with foresight have already set up their own scientific organizations. There are a number of problems, however, so fundamental that it seems worth while to attack them through some coöperative effort. The Glass Division passed a resolution to appoint a committee which will coöperate with the National Research Council, Division of Research Extension, for the purpose of canvassing the field. This committee will consider first, the problems which are suitable for such a study, choosing from the number a few to comprise the initial program; second, the facilities available for the work; third, the personnel having suitable training and experience; and fourth, a proper plan for financing the undertaking.

A Glass Research Association has already been formed in Great Britain and work there has actually been done. It is hoped that the movement which has started here will make rapid headway.

Forging Iron-Nickel Alloys

IT has been established that pure iron-nickel alloys do not forge satisfactorily at ordinary forging temperatures, and at the Westinghouse Research Laboratory an investigation has been under way to determine what treatment would make such alloys more readily forgeable. It has been found that aluminum, chromium, magnesium, and silicon have scarcely any effect, but that in amounts of two per cent of the lesser constituents, manganese or titanium imparts the desired characteristics and makes the alloys forgeable.

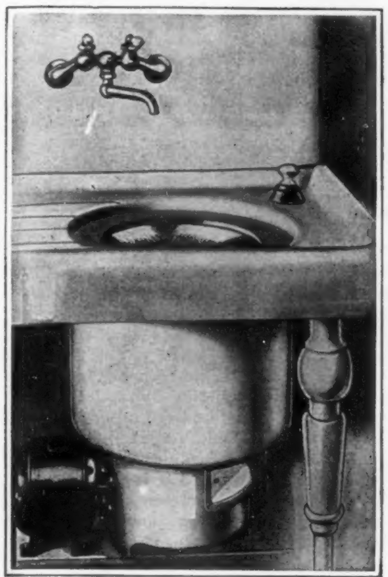
It is believed that these elements have the ability to strengthen the amorphous inter-crystalline material to the point where it possesses greater strength than the crystals.

Coals for By-Product Coking

WHILE the chemist can make an accurate analysis of coal, it is not generally understood that such analyses cannot give results in terms of by-products from gas or coking operations. The chemist determines the elements which, under suitable conditions, combine to form ammonia, benzene, toluene, tar, etc., but he does not separate the coal into these substances. The amount of these by-products which will be produced depends upon many conditions, and indeed more upon the operation of the plant than upon the character of the coal. It is necessary to coke coal under commercial conditions and even a small-scale plant can do no more than indicate the possibilities so far as our present knowledge is concerned. In all this work the laboratory and semi-commercial-scale plant is a very valuable guide, but the limitations must be recognized.

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts



Dishes are washed in the sink by means of this washing device

A Dishwashing Machine Right in the Sink

AN electric dishwashing machine which is built right in a porcelain enamel sink is a late product of a Chicago manufacturer. Power for washing dishes in this machine is derived from two perpendicular reels which throw the water with a tremendous force to the center of the bowl. The boiling water passes between every dish and flows off through the drain pipes. The dishes are placed in the machine in a permanent position and are not in motion during washing operations.

Any light socket or wall outlet will furnish the power to operate the ¼-hp. motor used with the combination machine.

Locking the Shoes Outside the Hotel Bedroom

THE thief, so it seems, is always with us, no matter whether it be in the taking of automobiles, boats, jewelry, clothes or even shoes. Just now it is shoes in which we are immediately interested.

The practice in most Continental hotels is to place one's shoes outside the hotel bedroom door, in order that the bootblacks may clean and polish the shoes and return them by the next morning. But with the greatly increased price of shoes it seems that a new form of petty stealing has come into practice, namely, stealing shoes. So serious has this threat become that an English inventor has worked out an ingenious form of lock which appears in the accompanying illustration. It consists of a U-shaped member whose legs are pressed down into a pair of shoes to be locked in place. In this manner shoes may be locked outside the bedroom door with full assurance that they will not be stolen by the petty thieves engaging in shoe stealing.

Pushing down the U-shaped member locks the shoes in place

Speeding Up the Camphor Harvest

DOWN in Florida and other Gulf States the camphor trees are cultivated in rows much the same as any other crop. Tillage is comparatively easy, but in harvesting the leaves and twigs the job becomes a tedious and expensive operation.

Heretofore the camphor-making material has been clipped from the tree by hand, which costly procedure doubtless is responsible for the advancing price of the product. But again the American inventor has come to the rescue in this all-important matter of reducing the high cost of production; this time it is the inventive skill of a specialist in the Bureau of Plant Industry, U. S. Department of Agriculture, that is responsible for a machine which strips the camphor trees of their leaves and small branches without injury to the limbs or impairment of the productive capacity of the trees. The machine, which is shown in the accompanying illustration, carries its own gasoline engine. As it is drawn between the rows of camphor trees, its cutting knife cuts off the leaves and small branches.

Hand work in harvesting camphor-making materials is done away with by this recently-introduced harvester

War's Explosives and Italy's Agriculture

WITH a view to disposing of the surplus supply of explosives and at the same time benefiting agriculture, many experiments have been conducted by the Italian Ministry of War in connection with the breaking of ground. The results have been so satisfactory that it has now been determined to proceed to the practical use of explosives in agriculture on a large scale. In addition to preparing the land for cultivation, it is claimed that the use of certain explosives not only destroys parasites but also to a certain extent reduces the necessity for fertilization. It is proposed to establish in all districts of Italy demonstration fields where trials of the system which has been adopted will be carried out; such fields have already been created in Umbria, Puglie, Tuscany, and the liberated Provinces. At the same time, the Ministry of War will turn over the large quantities of available explosives at favorable prices.

Gluing Mandolin Backs by Machine

A NEW time, space and labor saving automatic drying and gluing machine has been invented by the foreman in one of the largest manufactories of musical string instruments in the United States, located at Jersey City, N. J. This new machine, as can be seen herewith illustrated, enables the operator to glue and dry hundreds of mandolin and guitar backs in a short time. Ordinarily a mandolin or guitar back is glued and put in a device which holds the two pieces together under pressure, and then placed on the floor to dry. Hundreds of these upon a floor, especially in a factory, take up lots of room and take up many an extra hour with operatives who are being paid for their time. With the invention of this new machine a general saving is made by the firm.

The machine is operated in the following manner: Place a glued back on one of the racks, which are found on the revolving wheel or machine. When the rack reaches you for the second time the back is both dried and glued thoroughly. Then you are in a position to put on another mandolin or guitar back for drying and gluing.

This machine serves to glue hundreds of mandolins in a short time

A Turkish Bath for Milady's Hair

IT may be that one of the aftermaths of war is a most strenuous effort on the part of the fair sex to appear at its best. Those who are blessed with natural beauty seem to strive in every way to exploit their charms to the utmost, while those not so blessed strive a hundred-fold more energetically to acquire beauty in every possible manner.

However all that may be, the fact remains that inventors have been working on the problem of beauty with more than usual vigor. Numerous beautifying devices have been patented since the ending of hostilities, and more keep coming along week by week. All of which, to be sure, presages a genuine demand for such devices. The Turkish bath arrangement shown in the accompanying illustration is one of the latest devices along this line. It consists of a canvas hood, electric heater, and steam-producing arrangement. When the device is placed on the head and the current turned on, the hair of the patient is treated to a steam bath which, so we are told, is conducive to a wealth of beautiful hair.

Peat Fiber and the Textile Industry

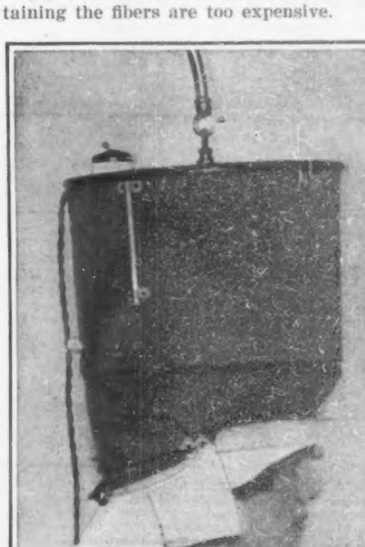
SWEDISH efforts to introduce peat fiber as a substitute article in the textile industry have come to naught for the moment. It is the consensus of opinion that the prices for extracting the fiber from peat moss must be economical before it will ever come into general use. Two factories, one in Denmark and the other at Partille, near Goteborg, Sweden, both established during the war for the purpose of utilizing peat fiber, have had to close their doors in recognition of this fact.

The experts appointed to make the investigation have completed their labors, and, among other things, found:

(1) Good textiles of peat fiber and "shoddy" can be manufactued and samples were demonstrated, but

(2) The Swedish peat mosses can produce only 100 kilos of fibers and moss per day, which is not sufficient for commercial purposes.

(3) The methods so far used in obtaining the fibers are too expensive.



This electrically-operated device treats the patient's hair to a Turkish bath

Our Future Oil Supply

(Continued from page 102)

barrels of oil a day settled production, more than our famous fields of Ranger, Desdemona and Cushing combined, with their thousands of wells. Against them all stands the peerless Cerro Azul No. 4 alone, with its depth of but 1,752 feet, and proudly outmatches not wells or even single pools, but groups of fields instead, keeping up an output which they can only maintain by means of the constant addition of new wells. During the first week when it came in that one well alone produced about one-sixth as much oil as all the wells in the United States together.

Then comes the Juan Casiano, with its output to the present of over 8,000,000 barrels and which still is producing at the rate of 23,000 barrels a day through a damaged valve, and the Portrero del Llano, which produced 100,000,000 barrels before it was drowned out by salt water. It flowed 46,000 barrels a day for years—a greater output than the entire Healdton field of Oklahoma—the casing being defective, and great seepages coming up through the ground for a radius of half a mile. Truly, Nature has been kind to Mexico!

A flood of oil like that set forth in these figures is hard to comprehend, and still more bewildering when translated into dollars and cents.

These wells are by no means alone. There are others that stand out as giants among the wells of the world. Two were brought in a short time ago with an initial or flush production of between 60,000 barrels and 80,000 barrels a day, the latter having a production almost as great as America's largest field—the well-known Burkburnett pool of Texas; and dozens of others run as high as many of our smaller fields. Indeed, a report places a recent daily output of three hundred and five Mexican wells at 1,925,233 barrels, or 6,312 barrels per well! An average of 200 barrels a well for an entire field is regarded as exceptional on this side of the Rio Grande. Mexico's total supply comes from but little over 300 producing wells, which have only been run irregularly; and yet these with their partial output produce annually the equal of 37,500 wells here, or approximately one-sixth as much oil as the over 225,000 wells in this country.

The Mexican fields are divided into three districts or zones. The heavy crude oil is produced in the "Northern Field," lying west of Tampico, and comprises the Ebano, Panuco and Topila fields, of which Panuco is the most prolific and Ebano the scene of the first gusher in Mexico. The oil is from 8 to 15 (Beaumé) gravity.

The "Southern Field," or the light oil district, begins at Tepetante, about 72 miles south of Tampico, and extends 36 miles to the south of the Tuxpam River. The oil is about 22 (Beaumé) gravity. It is here that the famous oil bearing Tamasopa or honey-combed limestone is encountered, which is stated to have a thickness of one or more miles, and which accounts for the wonderful capacity of the wells. This field was opened in 1910 with the great Juan Casiano and Portrero del Llano wells previously described.

The third zone is still farther south on the Isthmus of Tehuantepec, and is known as the "Isthmus" or "Tehuantepec" field. While the production at present is not as great as that of the others, the oil is of much higher quality, about 37 Beaumé, and vast stretches of probable oil territory in Tabasco, Campeche, Yucatan, Chiapas and Quintana Roo have not even been prospected. It is in this field that the Pearsons of London have their well known Salat well, and also their refinery at Minatitlan.

These three districts form the producing fields of Mexico today—starting with the low grade oil in the north and increasing in quality toward the south. The west or Pacific coast has not yet been developed for oil but portions of it look most encouraging, especially parts of the Pacific littoral of lower California, which the Mexican official reports designate as a petroleum-bearing region. Oil outcroppings are found there in several places and the geological formations give most favorable promise. The large companies are reported to have acquired huge domains in this section and geologists claim that some of the greatest deposits will be uncovered there.

In the eighteen years in which the writer has known Mexico he has never encountered anything but exceptional courtesy from her people, or other than utmost consideration from the government despite the fact that he has been there in most trying times.

Verily, Mexico is a land of riches. Nature has given her every available climate, elevation and geographical and topographical formation—a soil that in places is a marvel of production, fisheries of great richness, mines that produce gold, copper, antimony, etc., and for years contributed one-half of the world's supply of silver—and below lie the vast reservoirs of petroleum, which today have hardly been tapped and the possibilities of which have not even been explored. These fields now bid fair to see a campaign of development that will again startle the world and that will add untold millions to its wealth.

Scrapping Good Machinery for Better Service

(Continued from page 103)

wires in a single cable and cables laid as late as 1916 contained circuits having 320 pounds of copper per mile. Today cables containing only 80 pounds of copper per mile are being used with better results. At the same time cables which were useful only for very short distances have been improved so that now conversations are regularly carried on over a thousand miles of cable. New inventions make it possible to talk from New York to San Francisco by cable with no more difficulty than was experienced only a few years ago in talking from New York to Boston on overhead wires. The present advantage of cables over wires is so obvious that this replacement is taking place all over the country just as fast as the new equipment can be manufactured. It is estimated that the saving to one company from this single change, ten years hence will amount to $5,000,000 a year!

Of course these two improvements in telephone service—the automatic connection and the cable—are largely an apparatus with which the average subscriber does not come in contact and about which he does not bother. But within the memory of nearly all of us, the telephone instrument itself has been replaced several times. It wasn't so long ago that we were talking into great cumbersome battery phones that hung on the wall, and were calling "central" by cranking a little magneto. This has evolved into the convenient desk phone of today. Each replacement has meant the expenditure of millions of dollars and the saving of many other millions.

Today there is a great engineering laboratory in New York employing 3,125 men and women, which has as its sole purpose the improvement of telephones and telephone systems. During the past year this laboratory has actually prosecuted work on more than five hundred improvements in the telephone art. All of these promise advances in the interest of service or economy. Many have reached the point where success is assured. Others will require many years of development before any practical results can be seen. Some of them look so visionary and unpractical that it seems a waste of money and time to carry them further. Yet thousands of dollars are spent on such things annually in this laboratory. And it pays!

It must not be inferred that the laboratories which are responsible for great advances in public service are an inventor's paradise or that every new invention wins instant recognition from a wizardly set of directors. The men who direct these laboratories are serious-minded scientists and engineers, who arrive at their conclusions after most thorough study and experiment. There is nothing haphazard about it and when a great advance is ready for practical application it has been calculated beforehand just what the saving will be and it has already been demonstrated on a small scale. That is why it pays.

The Romance of Invention—XV

(Continued from page 104)

fessor Michelson, one of the greatest living authorities on such matters, happened along in time to express his interest and declare their genuineness to the discomfiture of Mr. Ives's critics.

Mr. Ives has been responsible for so many oddities in light, color and picture that a catalog would be almost wearisome. But it would be criminal to neglect to mention the binocular microscope which can be used with high powers as well as low, and for stereoscopic photomicrography under high powers Mr. Ives has made stereograms of small diatoms which, when viewed in a stereoscope, have the appearance of richly carved cut glass dishes. Any microscopist who has first found, then resolved, and finally studied these diatoms, famous test objects for fine lenses, will appreciate that a device which will make steographic photographs of them through an oil immersion one-twelfth at 1,700 diameters is worth mentioning here!

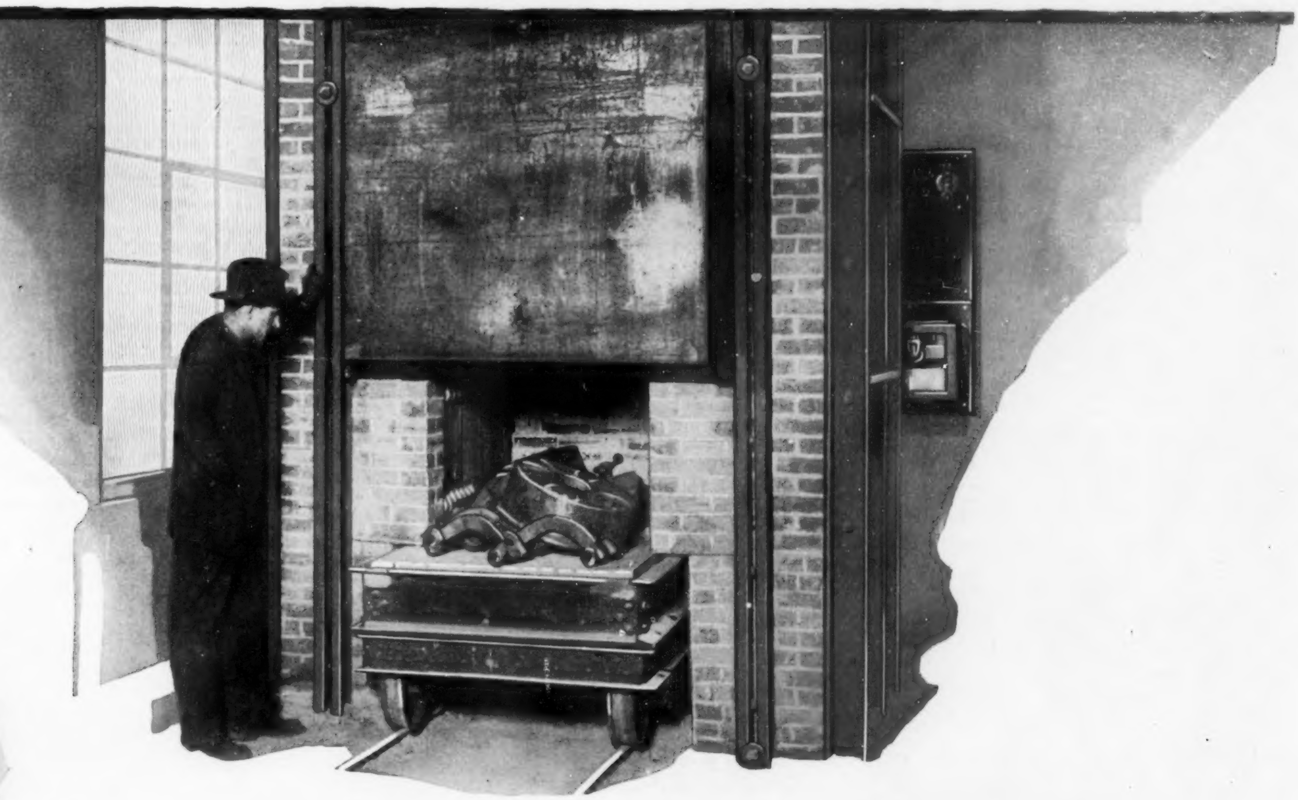
Mr. Ives was born in Litchfield, Connecticut, where his father first had a farm and then conducted a store. The young Ives started as a farmer boy and a store keeper. While in the store he took up amateur printing and at the age of 16 was a journeyman printer and amateur photographer by the old wet plate process of that day. He made his first camera out of a cigar box and spectacle lens and made good negatives with it. He then went to Ithaca and there, as a lad of nineteen, applied to Professor Anthony for the job of photographer in the University photographic laboratory. The learned professor would have none of him at first on account of youth and inexperience, but Ives persevered until he was allowed to try, probably as the easiest way of getting rid of him. He stayed four years because, as Professor Anthony said, before he came they had never been able to get such good work done.

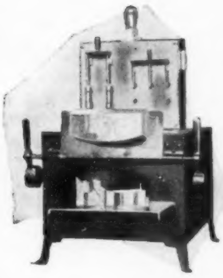
During this time Mr. Ives endeavored to learn wood engraving, but without distinguished success. It was to substitute for the engraver's "V-shaped tool," a "V-shaped graver of light" that he went to work, the result being the familiar half-tone process. Worked out first as a photomechanical process and introduced commercially in February, 1881, in 1885 and 1886, the present-day half-tone screen system was developed from it and that process given the world which made the modern illustrated paper possible and revolutionized the printing industry. Incidentally, it may be mentioned that Mr. Ives has in his files a patent applied for in 1891 for the type of intaglio printing plate used in the present system of rotary photogravure, which illustrates in brown ink our familiar Sunday supplements.

Following the half-tone process, the three-color process was Mr. Ives's work, and to his genius and knowledge of optics we owe that wonderful art by which colors as nearly natural as pigments can accomplish can be laid on paper by the printing press in thousands, even millions, of copies in a short time.

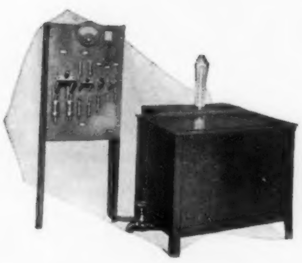
(Continued on page 114)

Perhaps the surest proof that electric heat has graduated from the experimental class is the use of 1,000,000 kilowatts for industrial applications





Muffle type heat treating furnace



Electrically heated oil tempering bath

Core baking oven

A Furnace that can't get too hot

WHEREVER human life depends on pieces of steel for safety and strength, as in axles, wheels, gears and many other parts of machinery, the heat treating of those steel forgings or castings is all-important. Too much heat is just as bad as too little, and a few degrees either way is enough to make the steel unfit for its purpose.

Since accuracy of temperature is so vital in heat treating, the electric furnace far surpasses any other form of heat, because its control is absolute and its results are constant, day after day. If a certain temperature is required, the electric furnace will not only maintain that *exact* temperature for any given time, but will distribute the heat evenly in every part of the furnace, so that the product to be treated will receive the same amount of heat from all sides, top and bottom. This is all done automatically, with one man controlling several furnaces.

Improved working conditions, such as absence of noise and excessive heat, perfect cleanliness, and simplicity of operation tend to make happier workers and better work. Production is increased and costs decreased through more uniform results, minimum amount of re-working, and less distortion of forgings.

G-E electric heating equipments are made for furnaces of various sizes, for temperatures up to 1800° F., and are being used for heat treating, annealing, carburizing, and hardening metals, in many industries.

While equipping furnaces constitutes a large part of the General Electric Company's share in the development of electric heat, there are many G-E heating devices for other purposes. From the miniature cartridge unit which heats a soldering iron, to the monstrous oven which bakes enamel on automobile bodies, electric heat has established itself firmly, and has exceeded the fondest hopes of its most ardent exponent.

The facts and figures gathered from hundreds of G-E installations are available to anyone who has an industrial heating problem, simple or complex.

General Electric Company

General Office Schenectady, N.Y.

Sales Offices in all large cities

59-41

The Romance of Invention—XV

(Continued from page 112)

Mr. Ives, while freely crediting to another the principles of panchromatic photography, was the first to realize a successful process in commercial practice. His inventions also include a color meter—a device for measuring color and tints which has the possibility of more than one million variations, and of hundreds of variations of any one shade. Any color can be matched to the eye and expressed in simple numerical terms.

It must not be supposed from anything said above that Mr. Ives regards as impossible the making of color photographs on paper by a process so simple that any one can use it. His own "hichrome" process has been exploited commercially and does produce results which are beautiful and sincere. That it might be simplified is by no means, in the inventor's view, impossible. But he will tell an inquirer that inasmuch as nature provided three primary colors, which, by combination, produce the sensation to our eyes of all other colors, a less-than-three-color process does not appear feasible if it is to be truthful, and that wherever there are *three* negatives and *three* prints, which in one way or another must be presented as *one* to the eye, there must also be difficulties of manipulation and coördination that are apt to make trouble for the tyro. But he has by no means given up work either upon this or any one of a dozen other processes which he has and is working out, and indeed, is even now fitting up a new laboratory for the special investigation of color reproduction problems.

Mr. Ives believes that there is a great future for motion pictures in color, the colors of which will be nearly if not quite natural and which will be as much without flicker or mechanical or financial difficulties as the present black-and-white moving-picture films are; and he has high hopes of the commercial value of this, his latest contribution to the science of picture making.

That some one will make money out of it seems assured, even as millions have been made out of Ives's inventions by others.

"But I haven't time to make money," says Mr. Ives. "There is too much else to do."

Incidentally, it should be chronicled that America's foremost authority on the subject, who has been honored at home and abroad for his researches, his inventions, his papers and his knowledge, is *not* a graduate of any college and holds *no* degrees, probably for the same reason he hasn't made himself a fortune—he has been too busy making and perfecting inventions to have time!

Our Mechanical Eyes

(Continued from page 106)

red; gold, ruby; silver, yellow; iron, greenish; manganese, violet. If a smoked effect is desired, it may be obtained by combining several of the foregoing oxides.

The spectacle sheets are gone over and many discarded for lack of the desired excellence in some respect or other. The sheets which pass inspection are now cut into circles or ellipses by a special machine which operates a diamond cutter.

Optical flint glass, which contains a good deal of lead, may be prepared by using pure red lead to supply the lead, or else litharge (the semi-vitrified protoxide of lead). A normal flint glass will result from the use of 3 parts of sand, 2 of red lead, and 1 of potassium. The great difficulty in the manufacture of optical flint glass centers on the elimination of bubbles, strains and striae. The lead tends to sink because of its considerable specific gravity, so that the mass must continually be stirred. The melting of the metal may last a number of days, so that the stirring is by no means an evanescent job. It is undesirable to have the iron rod in contact with the glass. A curious device is used in this connection. The long iron rod is retained. It is bent, however, at right angles on the end, and this arm dips down into a clay vessel of cylindrical form. The bottom is closed, so that the vessel floats deeply in the molten glass. By manipulating the rod, the vessel is made to do the stirring instead of the rod itself. When the viscid condition is reached, the mass is permitted to solidify. Ordinarily, the crucible is sealed and left in the oven, the two to cool off together. After solidification, the crucible is broken open and the apparently good pieces of glass selected for tests as to optical qualities. If twenty per cent of the melt is usable, the manufacturer will be well satisfied.

There are special optical glasses which do not come under the lead and lime classifications. Various substances, such as bromic acid, phosphoric acid, fluorine, zinc and barium, have been pressed into service. The old crown and flint glasses have been surpassed in respect to the desirability of the refractive indices of the best of the newer products. Glass has been made containing absolutely no silicic acid. These types of glass are the result of the labors of the last 30 or 40 years.

Lenses of the commoner forms have binary combinations of plane, convex spherical and concave spherical surfaces. But the diverging types produced thus by no means exhaust the varieties now made and used for one optical purpose or another. In short, it has been found that the foregoing types did not cover all the requirements of defective vision. Thus, binary combinations of a cylindrical surface with plane and spherical surfaces have been found to produce lenses of distinct value to eyes unresponsive to the older forms. There is another type which demands notice. The convex member at the base of the ancient and classic architectural column—the member shaped like a doughnut or a life buoy—is called a *torus*. From this we have the adjective *toric*. Toric lenses are those having one surface agreeing in form with the convexity of the ancient torus. It is as if one bent a cylindrical surface so as to convert the rectilinear lines, called elements, to circular arcs.

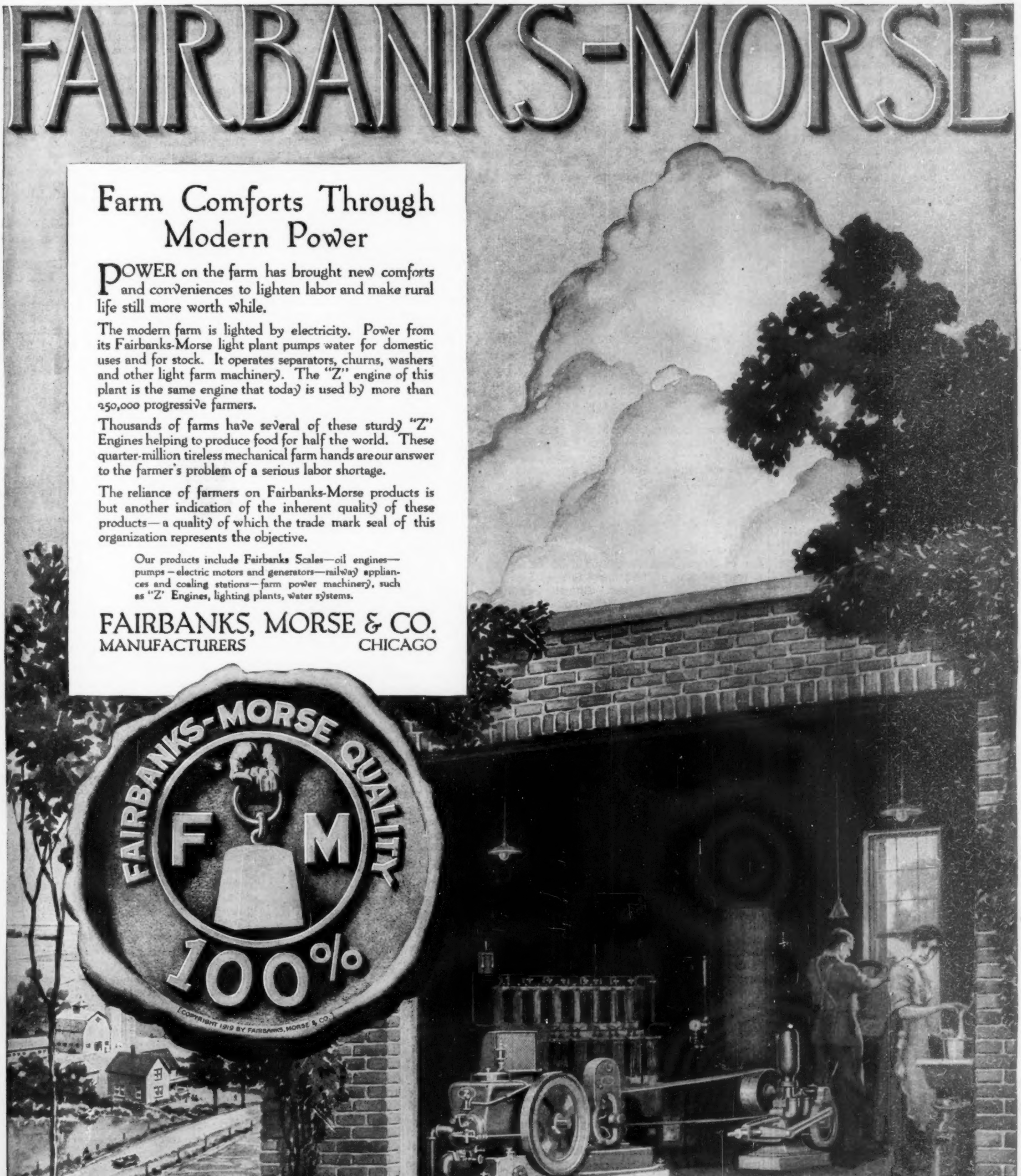
The ordinary elliptical lenses for spectacles and the like are made from rectangular blanks about 1.76 x 1.36 inches in size. This size is regarded as especially economical. From it may be cut all sizes. Cylindrical lenses may be made from blanks 1.68 x 1.68 inches in size. However, it has been found possible to grind the axes of cylinders diagonally and thus produce from the standard size of blank what is often a much larger lens than could otherwise be cut from it.

An automatic machine sorts the blanks for lenses, thickness being the basis of separation. The various blanks are thrown into receptacles devoted to the several gages of thickness, the work being done so accurately that the error is below 0.01 inch.

The grinding of the blanks is accomplished by one large concern in the following manner: Warm pitch is employed as a thick surface coating of the grinding block. In this are placed a lot of the elliptical blanks. The block is given its covering of pitch by being pressed into a mold into which hot pitch has previously been poured. The block itself is preheated to facilitate matters. Upon cooling off, the block is withdrawn and the lenses, having in the meantime been heated on hot tables, are placed upon certain projections but in the layer of pitch. The block and its charge of blanks are now allowed to cool off, the pitch hardening and securing the blanks firmly in their respective positions.

The blanks are now ready to be ground. The block is set in place on the spindle of the grinding machine. That is, the exposed glass surfaces are now ground

(Continued on page 116)


FAIRBANKS-MORSE
Farm Comforts Through Modern Power
POWER on the farm has brought new comforts and conveniences to lighten labor and make rural life still more worth while.
The modern farm is lighted by electricity. Power from its Fairbanks-Morse light plant pumps water for domestic uses and for stock. It operates separators, churns, washers and other light farm machinery. The "Z" engine of this plant is the same engine that today is used by more than 250,000 progressive farmers.
Thousands of farms have several of these sturdy "Z" Engines helping to produce food for half the world. These quarter-million tireless mechanical farm hands are our answer to the farmer's problem of a serious labor shortage.
The reliance of farmers on Fairbanks-Morse products is but another indication of the inherent quality of these products—a quality of which the trade mark seal of this organization represents the objective.
Our products include Fairbanks Scales—oil engines—pumps—electric motors and generators—railway appliances and coaling stations—farm power machinery, such as "Z" Engines, lighting plants, water systems.
FAIRBANKS, MORSE & CO.
MANUFACTURERS CHICAGO
FAIRBANKS-MORSE QUALITY
F M
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Our Mechanical Eyes

(Continued from page 114)

against a spherical surface which forms the inner surface of a bowl. The abrasive material is emery powder or an equivalent. The larger grain sizes are first employed and then the smaller ones.

The next machine operation is that of polishing. Before or during this procedure, scratches may be discovered on the ground surfaces of the lenses. If so, the block must be ground again, as the removal of actual scratches is not a job for the polishing machine. A block with its complement of lenses perfectly ground is now set in or on a fixed holder in the polishing apparatus. The polisher rotates over the block polishing the various lenses by means of fine polishing material. The polisher is a shell having the same curve as the block and containing a lining of heavy felt which is cemented to the shell. The curvature of the block is vital and must be maintained. In hot weather this may be difficult or impossible to do, if the lenses are not kept moist and the temperature thus held down.

The lenses are now to be ground on the reverse side. The first step after removal from the old block is gaging for thickness, this dimension being now of very great importance, largely because one side is already finished. The grinding and the polishing are processes similar to what they were before. Inspection is, naturally, an important matter. If a lens is of first grade then it must show no defect within an ellipse 1.56 x 1.20 inches set within the lens size 1.76 x 1.36 inches.

It has already been noted that a residue of 20 per cent acceptable glass from a melt of lead optical glass is satisfactory to the manufacturer. But the percentage is often much less. Sometimes it is as low as 10 per cent or less. Here we have a reason for a higher price for lead optical glass than for commoner varieties of glass. All this is accentuated, when it is necessary to find glass for the objectives for great refractive telescopes. It is only rarely that a single block can be found which weighs as much as 100 pounds, if perfection in quality is desired. "A single fine vein, perhaps too small to be visible to the unaided eye, may be found to run through a whole block in such a way that it cannot be removed without breaking or cutting up the whole piece, and it will be seen that the frequency with which this is liable to occur increases with the volume of the piece required."

Lighthouse lenses are made from glass which is manufactured by a somewhat different process. Instead of letting the mass of molten glass cool down in bulk and break up into fragments, it is poured into iron molds which give it approximately the final form desired. It is then ground and polished to exact size and figure. Rings for annular lenses are produced up to 48 inches in diameter. Segmental rings are made of still larger diameter—up to 7 feet. Most lighthouse lenses are of lime glass, but for special purposes a dense flint glass is made with a higher refractive index.

Learning by Seeing

(Continued from page 107)

of the cutlery works at Sheffield, England. Subsequently he has extended this original and initial idea until at present the index of motion picture subjects offered by the Holley organization includes practically every mechanical, medical, industrial, commercial and scientific activity adapted to portrayal by pictures. Recently Dr. Holley has made arrangements with the National Department of Agriculture so that, henceforward, he will distribute the interesting films of this government agency not only throughout America but to every nation under the sun which wishes to learn about more progressive systems of farming.

Matters of personal hygiene, first-aid systems of treating wounds, the care and nutrition of infants, methods of sanitation as well as the rudiments of the three R's are now taught by pictures, the six million odd mountaineers of the Appalachian Mountain belt being the beneficiaries. The films and motion picture equipment are carried into the mountains on mules, the creek bottoms and trails being impassable for other methods of transportation and railroads in those regions being few and far between.

Despite the fact that the Bureau of Commercial Economics has over 35,000,000 feet of negaitve in daily use, last year it was able to supply only 45 per cent of the requests for film which it received. The Americanization of our foreign born laboring classes is a matter of critical concern at the present time and for educational work of this description the motion pictures speak the universal language. They appeal forcibly to both literate and illiterate and for the visualization of current ideas and patriotic events in American history, the motion picture is the perfection of pictorial appeal. The educational "movies" provide wonderful short cuts and top speed processes for the tutelage of the immigrant classes.

Motion picture trucks—unique among the "movie" theaters in the universe which travel from point to point in the rural districts of various foreign countries—carry the teachings of filmdom to millions of peoples each year. One of the trucks is on the Island of Sumatra off the Malay Peninsula where tens of thousands of natives work on the rubber plantations. Another outfit at Singapore furnishes highly prized amusement to the local laborers. The natives of the Island of Java sit about on mats, chewing betel nuts as they watch the marvelous picture shows which the "movie" truck provides for their entertainment. Other similar outfits are operated on the Island of Ceylon and in the Levant. The Bureau also maintains a film service which displays pictures on many of the river steamers in Russia in coöperation with the Siberian Steamship Company. In addition the Bureau has over 600 established centers in Latin-America, the chief difficulty being to supply sufficient negative to satisfy the continuous demands from Argentina, Bolivia, Chili, Mexico, Brazil and Nicaragua.

The Heavens in August, 1920

(Continued from page 109)

use of mariners. The predictions made in this way are very good, except when exceptional weather conditions—such as a gale blowing the waters of a long bay or estuary toward one end—introduce unpredictable complications. It is probable, however, that only a small proportion of the mariners who make use of these predictions have any idea how they are made.

The Heavens

The principal constellations are so clearly shown on our map that no long discussion is necessary. Cygnus and Lyra are right overhead, at the hours tabulated below the map for the different dates. Aquila, Sagittarius and Scorpio lie to the south and southwest, along the brightest part of the Milky Way. Ophiuchus, Hercules and Bootes are in the west and southwest, Draco and Ursa Major in the northwest. Cassiopeia and Cepheus are in the northeast, with Perseus rising below. Pegasus and Andromeda are high in the east, Aquarius and Capricornus in the southeast, and Fomalhaut below them.

The Planets

Mercury is a morning star and is best to be seen about the middle of the month, when he rises at 3:45 A. M. (standard time).

Venus is an evening star, setting from half to three-quarters of an hour after sunset, and hard to see.

Mars is in Libra, and comes into quadrature with the sun on the 3rd, after which he may be considered an evening star, though he remains in sight until between 10 and 11 P. M.

Jupiter is an evening star at the beginning of the month, though too near the sun to be easily seen, but passes through conjunction on the 22nd, to reappear as a morning star next month. Thus we have the final breaking up of that brilliant combination of the three planets Mars, Jupiter and Saturn which has given the evening skies in this part of the world such unaccustomed brilliancy during the spring and early summer.

Saturn too is an evening star, setting an hour later than the sun in the middle of the month.

Uranus is in opposition on the 27th. He is then in Aquarius, in 22h. 23m. 34s. R. A., and 10° 54′ south declination, and is moving 9s. west and 52″ south per day. There are no convenient stars nearby to serve as guides, and he can best be identified with the aid of a good star map.

Neptune is in conjunction with the sun on the 3rd, and is invisible this month.

The moon is in the last quarter at 8 A. M. on the 7th, new at 11 P. M. on the 13th, in her first quarter at 6 A. M. on the 21st, and full at 8 A. M. on the 29th. She is in apogee on the 24th, and in perigee on the 12th—near new moon, so that high and low tides may be anticipated.

During the month she passes near Uranus on the 2nd, Mercury on the 12th, Neptune on the 13th, Jupiter and Venus on the 14th, Saturn on the 15th, Mars on the 20th, and Uranus again on the 29th.

On the afternoon of the 8th, Venus and Jupiter are in conjunction and only 40′ apart. This would be a handsome conjunction if the planets were not so near the sun that they will be very hard to see.

Clark's Island, Plymouth, Mass.
July 17th, 1920.

The America's Cup Races

(Continued from page 108)

footed faster. Every yachtsman knows what that means. The "Resolute," beautifully sailed by Charles Francis Adams, turned the outer mark with a lead of 2 minutes 4 seconds, and down the wind "Shamrock" beat her by exactly that amount.

That two yachts of such radically different design should sail for a distance (actual) of 37 miles at an average speed of 9 knots and finish in a dead heat, is unique, surely, in the annals of yachting.

The "Resolute" won, therefore, by exactly her time allowance of 7 minutes 1 second.

If the cup is to remain in the custody of the New York Yacht Club, "Resolute" must now win two races, straight.

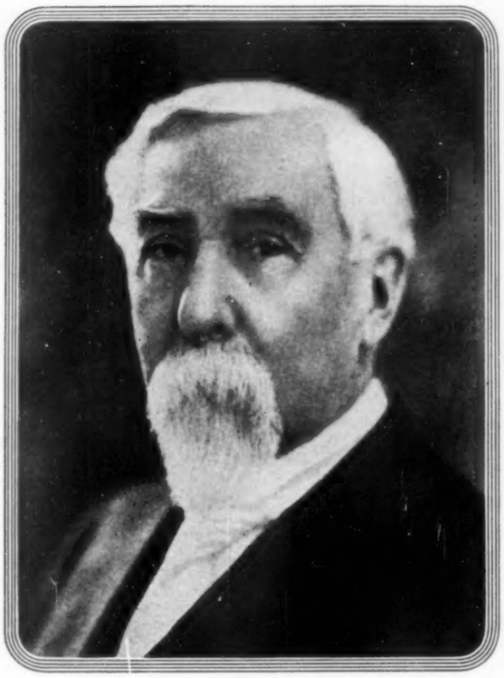
Australian "Blackboy" Tree

A PECULIAR product of the vegetable world is what is known as the "blackboy" tree which flourishes in the state of western Australia. It is, in fact, a species of the grass tree, and grows to a normal height of 7 to 10 feet, and is found to be useful for a variety of purposes.

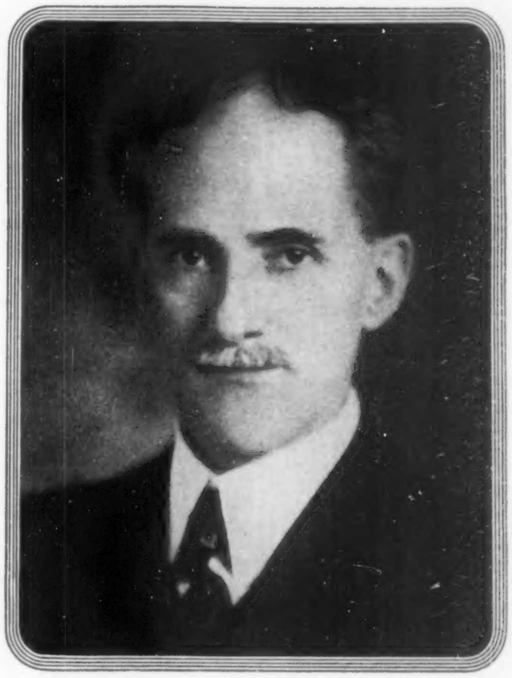
Until recently no attempt has been made to utilize the tree commercially, but a company has now been formed to work and market its by-products. The plant consists of 19 sets of retorts and furnaces, condensers, receiving tanks, etc., and can deal with 100 tons of gum and other material derived from the tree. The company at present employs about 20 men, besides cutters, and among other things being produced are tars (free from harmful acids), tarpaulin dressings, rope tar, and sanitary tar, lacquers (such as Japan black), steam and refrigerating pipe lagging, paint for ironwork that requires stoving at high temperature, stains and paints, pitches for marine insulating, phenol, benzol, and alcohols, coke, potash, and pyrogeneous acid. The production of dyes, perfumes, and formalin, and various kinds of varnishes is also planned.

In Anticipation of a Motor Car

Almost 2,000 Distributors and Dealers apply for Sales Franchise, and more than 1,000 individuals place orders for Lincoln Motor Company's new Leland-built car



Henry M. Leland
President Lincoln Motor Company



Wilfred C. Leland
Vice-Pres. and Gen'l Mgr. Lincoln Motor Company

It is doubtful whether any event in motordom has ever created such profound interest as the mere anticipation that a new motor car would be built by the Lelands and their splendid organization.

When, after the armistice was signed, and the Lincoln Motor Company—of which Henry M. Leland and Wilfred C. Leland were the chief executives—was completing its contracts with the government for the production of Liberty Aircraft Motors, it was only natural for the world to assume that these men would re-enter the field as makers of motor cars of the finer sort.

Notwithstanding the Lelands had made no announcement—in fact themselves had not determined upon their future activities—the offices of the Lincoln Motor Company became the Mecca of motor car distributors from all over the world.

These Distributors, most of whom were already handling cars of the better class, insisted upon filing applications for sales franchises and binding them with deposits.

Incidentally, one Distributor tendered a certified check for one million dollars ($1,000,000.00) as a deposit, to evidence his good faith.

From one city there were 61 applications; from another 38; from another 37.

There is scarcely a city of size in America from which there have not been from one to a dozen or more Distributors' applications. From cities in the United States and Canada, up to June 1, 1920, the applications totaled 1252.

And from across the seas, from nearly every country in the civilized world, the applications aggregated 123.

Of these, 13 were from England—where the esteem in which Leland standards and Leland ideals are held, is second only to the admiration in which those qualities are held in America. 8 were from Cuba; 9 from Argentina; 6 from Australia; 5 each from France and Spain; 4 each from New Zealand, Sweden, Norway and Hawaii. And they came from Russia, China, Japan, Straits Settlements, Union of South Africa, and from the uttermost corners of the earth.

To June 1, 1920, the Distributors' applications had reached the impressive total of 1375, not taking into account hundreds received since that date, nor the hundreds of applications made direct to Distributors by dealers in the smaller cities.

It will be seen therefore that we have been in position to select as our Distributors, the very cream of the trade, and to embark with a field sales organization in every way in keeping with the car itself, with the organization which produces it and with the class of citizenship to whom a car of the Leland-built type must naturally appeal.

And in not one single instance did the Lincoln Motor Company solicit a Distributor.

Nor was this all.

In addition to the Distributors' applications, more than 1,000 individuals have placed orders with deposits, despite the fact that the Lincoln Motor Company had made no announcement concerning the details of its car, and, too, despite the fact that the Company had not encouraged advance orders. There are also, in the hands of Distributors, hundreds of orders of which the factory has not been advised in detail.

Imagine, if you can, the attitude of these Distributors, who solely through their faith in the Lelands, deliberately obligate themselves to merchandise millions of dollars' worth of motor cars.

Imagine the attitude of these clear-headed business men, representing the best citizenship of the land who, with confidence in Leland ideals and standards as their sole incentive, coolly affix their signatures and place deposits, in order that they may be among the early ones to possess the new Leland-built cars—cars of whose price and details their knowledge was nil.

No matter whether it was to have one cylinder or ten; no matter whether its price was to be six hundred or six thousand dollars, these seemed to be of secondary importance.

But they knew the history of the men; they knew their records. They knew the Leland traits; they knew the Leland traditions—never to retrograde, never even to pause; they knew that the Leland vision was always forward.

So of one thing they were supremely satisfied. They were sure that if the Lelands built a car, it would be a car such as the Lelands know how to build; plus Leland progressiveness; plus what might logically be expected of Leland determination and Leland ability to achieve—and to surpass.

LINCOLN MOTOR COMPANY DETROIT, MICHIGAN